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FOREST HILLS-NEEDHAM CORRIDOR: RIDERSHIP FORECASTS FOR TRANSIT-SERVICE ALTERNATIVES

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TITLE FOREST HILLS-NEEDHAM CORRIDOR:
RIDERSHIP FORECASTS FOR TRANSIT-SERVICE
ALTERNATIVES

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ABSTRACT

The Forest Hills-Needham Transportation Improvement Study was conducted to examine alternatives for the transit service for the Forest Hills-Needham corridor that will be most appropriate once the relocation of the Orange Line has been completed. The Orange Line is being relocated from the elevated structure over Washington Street to the railroad right-of-way adjacent to the tracks used by the South Side commuter-rail line and Amtrak.

This report documents the market-survey data and the estimates of transit-travel demand provided by the Central Transportation Planning Staff (CTPS) to the MBTA consultant conducting the overall study. CTPS gathered the best available socioeconomic and travel data on the residents of the market and study areas. Base-case 1985 ridership forecasts were made, using previously calibrated trip-generation formulae, historical survey data on Needham commuter-rail and express-bus service, and recent employment and population forecasts. Ridership forecasts for three transit-service alternatives were made, based on projected socioeconomic changes and the service alternatives defined by the consultant.

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PREPARED FOR THE BENEFIT AND USE OF THE MUNICIPALITIES CONSTITUTING THE
BOSTON METROPOLITAN AREA PLANNING DISTRICT

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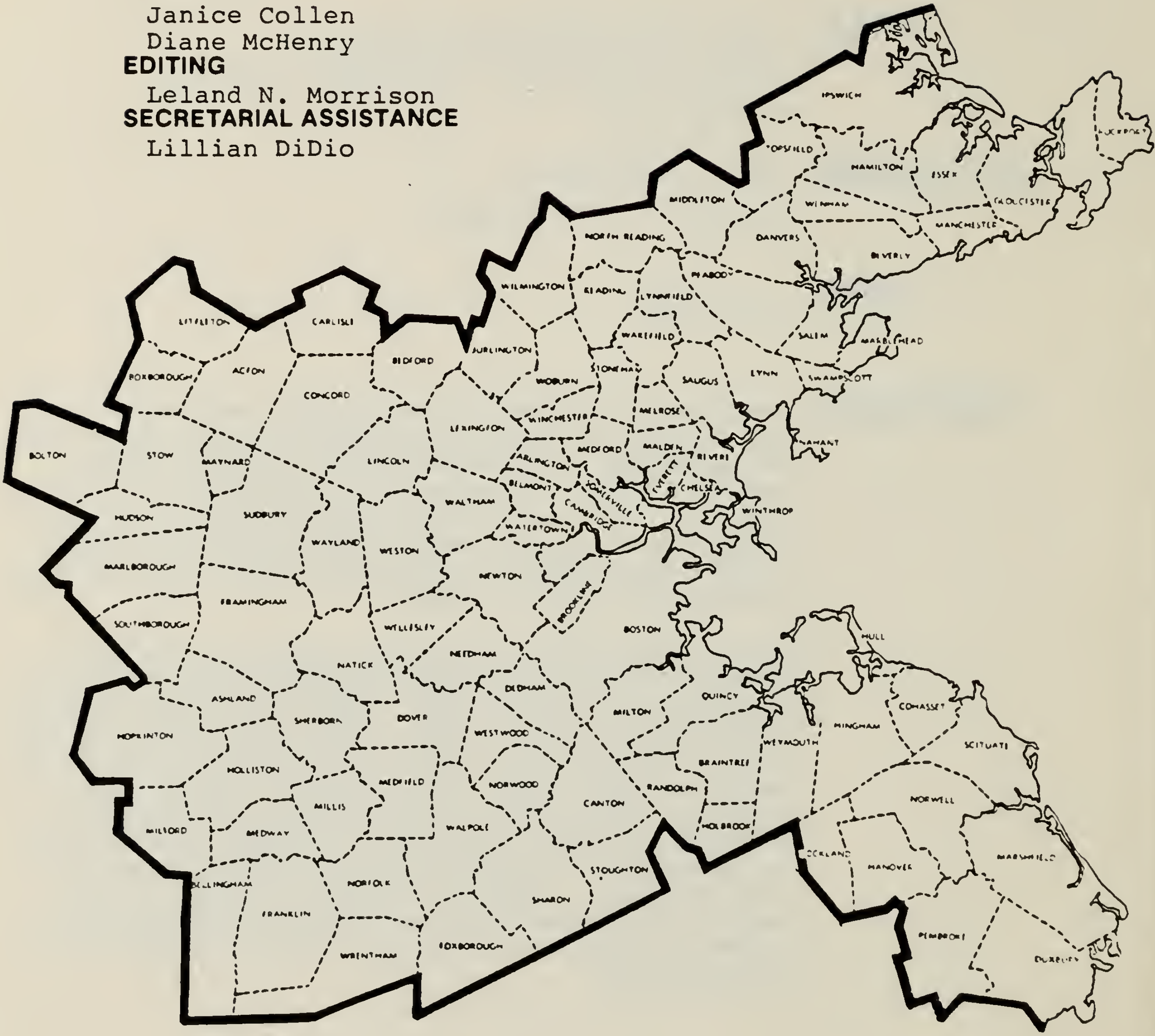

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1.0 INTRODUCTION

As part of the Southwest Corridor project, construction is currently underway to relocate the MBTA Orange Line from the elevated structure over Washington Street to the railroad right-of-way adjacent to the tracks used by the South Side commuter rail line and Amtrak. The new line will diverge from the current path just south of Essex Station, travel through an extension of the existing tunnel, and rise to grade level at the railroad right-of-way which parallels the Massachusetts Turnpike. Continuing along the railroad right-of-way, the line will terminate at Forest Hills. From Northeastern University to Forest Hills, the railroad tracks are currently located on top of a berm. The plan calls for removal of the berm and depression of the tracks. Crossing streets will be bridged over the right-of-way.

Needham Branch commuter-rail service had to be temporarily discontinued to accommodate the needed construction. Other lines were rerouted, but this was impossible for the Needham line. During the disruption in service, the MBTA has provided express-bus service from Needham, and separate express-bus service from Roslindale and West Roxbury. Surplus equipment and train crews were placed on the Framingham commuter rail line, increasing the frequency of service. Riders in West Roxbury and Roslindale also had local-bus service feeding the Orange Line's Forest Hills Station.

The Forest Hills-Needham Transportation Improvement Study was conducted to study the commuter-rail and bus alternatives which can be implemented in the Forest Hills-to-Needham travel corridor once the Orange Line relocation is complete. The consulting firm of C. E. Maguire was selected to conduct the study and prepare a final report. The Central Transportation Planning Staff (CTPS) provided the consultant with market-survey data and an estimation of the transit-travel demand under each of the proposed alternatives, as documented in the present report.

The three alternatives are:

Alternative A - Commuter rail service from Needham through Roslindale and West Roxbury and local bus service in Roslindale and West Roxbury

Alternative B - Commuter rail and local bus service similar to that of Alternative A, but without service at the Bellevue commuter rail station

Alternative C - Express bus service from Needham and Roslindale/West Roxbury, with local bus service in Roslindale and West Roxbury

These alternatives are discussed in detail in Chapter 4.0.

A geographic and socioeconomic description of the market area and study area and a summary of study-area travel patterns are presented in Chapter 2.0 of this report. This data, which was used to forecast future transit ridership under the study's service alternatives, includes the latest population figures, estimates of future population, employment estimates by place of work, maps of the study area, a brief review of public transit in the study area, and analysis of trips within the market area and from the study area.

Chapter 3.0 and 4.0 of this report document the demand estimates for the study's transit-service alternatives. The methods used in making these forecasts are presented in Chapter 3.0, and the demand estimates for the three alternatives submitted to CTPS by C. E. Maguire are described in Chapter 4.0. The results are summarized in Chapter 5.0.

2.0 DESCRIPTION OF THE MARKET AND STUDY AREAS

In order to identify the areas from which users of the Forest Hills-Needham transportation service would be drawn, travel patterns within Eastern Massachusetts were reviewed. The 1975 trip tables prepared by Alan M. Voorhees, Inc., as part of the Eastern Massachusetts Planning Assistance Project, indicate that the majority of the residents in the corridor work in Cambridge, Dedham, Natick, Newton, Norwood, Waltham, Wellesley, and the various neighborhoods of Boston. People working in the corridor communities come from the communities named above and from Brockton, Dover, Framingham, Milton, Quincy, and Weymouth.

Although some residents of the communities bordering Needham on the northwest and south commute to Boston and could, thus, make use of the Needham-Forest Hills service, most either have alternative transit service or commute to Framingham and other communities which would not be served by the Forest Hills-Needham service. For instance, residents of the northern sections of Newton and Brookline are served by the Green Line, and Dorchester and Mattapan residents are served by the Red Line; these communities are therefore not included in the market area. Western sections of Cambridge are also excluded due to the lack of access to transit connected with the Forest Hills-Needham corridor, and most of Wellesley and Natick are left out of the market area since they are served by the Framingham commuter-rail line. Furthermore, the lack of Boston-bound commuters from Sherborn, Medfield, Weston, Walpole, Norwood, and Canton led to the exclusion of these communities (and those more distant from the transit corridor) from the market area. Some portions of Boston and Cambridge are included in the study area, as large numbers of corridor residents work there, but are not included in the market area, because they are not major sources of ridership.

Ten communities are identified in Table 2-1 as the most likely market area for transit service along the Forest Hills-Needham corridor. As indicated in Figure 2-1, the market area includes the communities bordering on Needham (in their entirety or in part), and part of Brookline. Cambridge and the central, southern, and western neighborhoods of Boston are added to the market area to form the study area.

2.1 SOCIOECONOMIC CHARACTERISTICS OF THE STUDY AREA

The market area for transit service in the Forest Hills-Needham corridor is the place of residence of nearly 160,000 people and

Community	CTPS Zones Within Community Included in Market and/or Study Area
Boston[1,2,3]	1-60, 81-130, 161-162, 168-174, 179-184
Brookline[4]	256
Cambridge[2,3]	200, 202-204, 209-220
Dedham	440, 441
Dover	521
Natick[4]	512
Needham	432-436
Newton[4]	352-353
Roslindale	163-167
Wellesley[4]	426
Westwood	442-443
West Roxbury	175-178

---

[1] Includes the following neighborhoods: Back Bay, Beacon Hill, Fenway-Parker Hill, Financial-Retail, Government Center, Hyde Park, Jamaica Plain, North End, Park Square, Prudential Center, Roxbury, South Boston, South End, and Waterfront

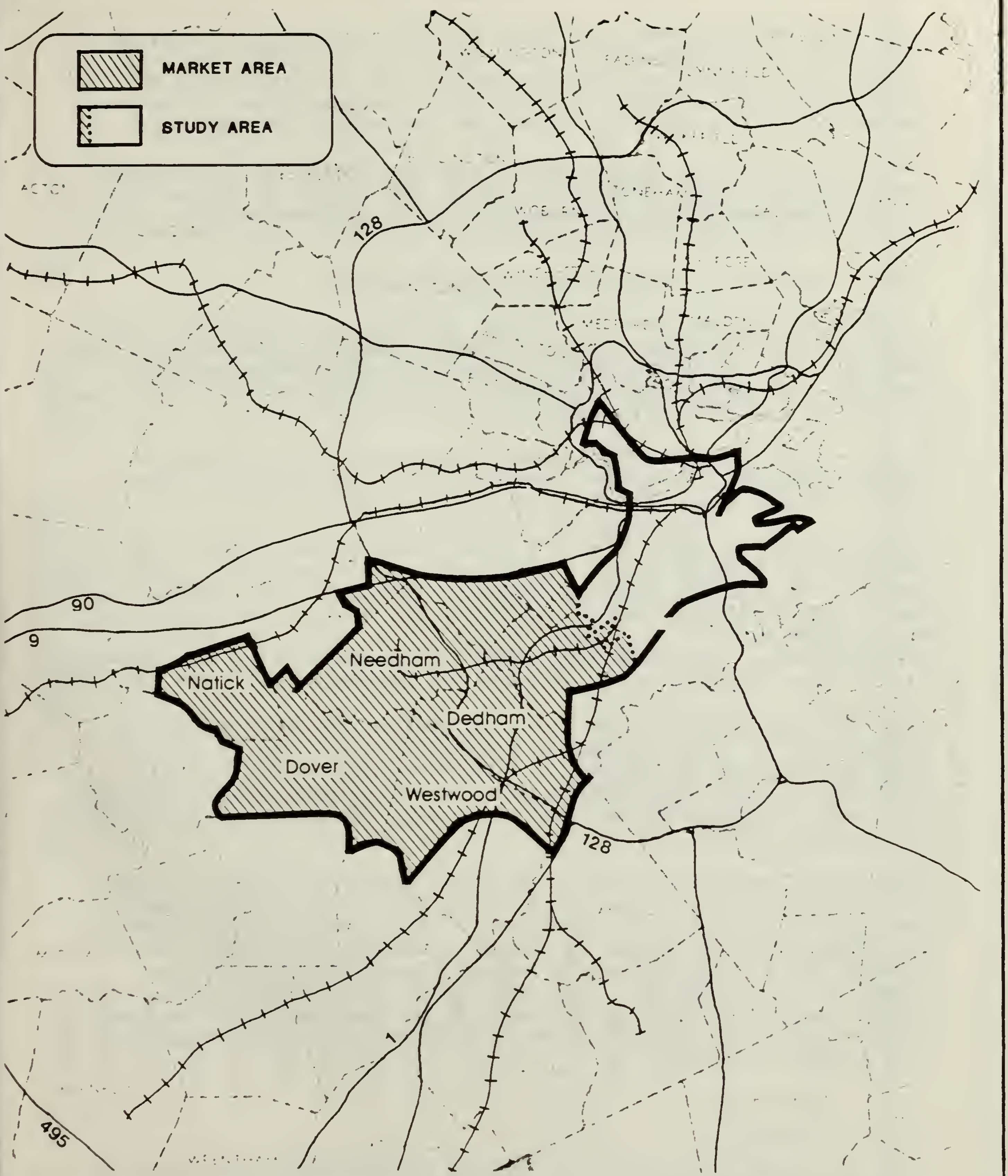
[2] Study area includes only portion of city

[3] Not included in market area, but serves as part of study area

[4] Market area includes only portion of town or city

DEFINITION OF MARKET AND STUDY AREAS

Table 2-1



MARKET AND STUDY AREAS FOR FOREST HILLS-NEEDHAM TRANSIT SERVICE

Figure 2-1

the place of employment for over 60,000, while the study area is the place of employment for over 540,000. In 1980, the mean income for families within the market area was about $35,900, and market-area residents owned over 91,000 automobiles, which indicates that there was one automobile for every 1.7 residents.

The concentrations of population and employment vary among the communities in the study area, as do the levels of income and automobile ownership of the residents of the communities. These characteristics are discussed in the following sections.

2.1.1 Population of Market-area Communities

Population counts from the 1980 U. S. Census of Population and Housing[1] indicate that the most highly populated market-area communities are the Boston neighborhoods of Roslindale and West Roxbury. As indicated in Table 2-2, they are home for 36 percent of the market area's residents.

Most of the remaining market-area residents live in Needham (nearly 28,000) or Dedham (over 25,000). The remaining communities each have under 15,000 residents.

As indicated in Table 2-2, the population of the market area is expected to fall by about 2.4 percent by the year 1985, with West Roxbury (7 percent) and Roslindale (5 percent) experiencing the most dramatic reductions. Brookline and Newton are expected to experience population losses of about 2.8 and 2.9 percent, respectively. The remaining market-area communities are expected to maintain fairly steady populations over the 1980-1985 period.

The 1985 population estimates are based on the forecasts presented in the 1982 Metropolitan Area Planning Council report, Regional Decline or Revival. Population changes over the 1980-1990 period are assumed to be at a uniform annual rate and the same in each study-area segment of a community as in the community as a whole.

Population counts from the 1980 U. S. Census indicate that less than 2 percent of all market-area residents are either Black (.7 percent) or Hispanic (1.1 percent). The greatest concentration of these minority groups is found in Roslindale, where nearly 3.5 percent of the population is either Black (1.2 percent) or Hispanic (2.3 percent). The only other market-area community with a minority share of its population greater than 3 percent is Newton, where about 2.2 percent of its population is Black and 1.1 percent Hispanic.

---

[1] U. S. Bureau of the Census, Census of Population and Housing - Population Counts, P. L. 94-171, 1980.

Community	1980 Population E&H[3]	 Black	 Hispanic	 Total	Total 1985 Population
Brookline[1]	1,286	57	97	5,975	5,807[4]
Dedham	3,021	70	130	25,298	25,300
Dover	477	8	27	4,703	4,700
Natick[1]	981	87	61	9,056	9,068[4]
Needham	3,127	86	163	27,901	27,900
Newton[1]	1,425	289	152	13,455	13,065[4]
Roslindale	4,866	322	651	27,963	26,614[5]
Wellesley[1]	172	5	2	1,788	1,787[4]
Westwood	1,228	23	54	13,212	13,200
West Roxbury	5,092	179	368	28,793	26,877[5]
MARKET-AREA TOTAL	21,675	1,126	1,705	158,144	154,318
Boston[2]	38,808	70,818	21,504	273,049	271,239[5]
Cambridge[1]	6,774	6,513	2,904	55,963	54,424[4]
STUDY-AREA TOTAL	67,257	78,457	26,113	487,156	479,981

Notes

[1,2,3,4,5] See following page for notes.

DISTRIBUTION OF 1980 POPULATION AND PROJECTED
1985 POPULATION IN MARKET AND STUDY AREAS

Table
2-2
(p.1)

Notes

[1] Only the portion of the community included in the study area

[2] Only the portion of Boston included in the study area but not in the market area

[3] Estimated from the percentage of the community's 1970 population over 65 years of age and the percentage of 1980 SMSA population under 65 with a public-transportation disability

[4] Assumes that the population within the selected portion of the community will change at the same rate as the community's total population

[5] Assumes that the population within the indicated Boston neighborhood will change at a constant rate between 1980 and 1990.

Sources

a. 1980 Population - U. S. Bureau of the Census, Census of Population and Housing: Population Counts (P. L. 94-171), 1980.

b. 1985 Population Forecasts - Metropolitan Area Planning Council, Regional Decline or Revival, 1982.

c. 1970 Elderly Population - U. S. Bureau of the Census, 1970 Census of Population and Housing: Boston, Massachusetts, SMSA Census Tracts, Report No. PHC(1)-29, May 1972.

d. 1980 SMSA Handicapped - U. S. Bureau of the Census, Provisional Estimates of Social, Economic, and Housing Characteristics: States and Selected SMSA's, Report No. PHC 80-SI-1, 1982.

Table
2-2
(p.2)

DISTRIBUTION OF 1980 POPULATION AND PROJECTED 1985 POPULATION IN MARKET AND STUDY AREAS

Over 13 percent of the market-area population is estimated to be elderly or handicapped, as shown in Table 2-2. The greatest concentrations of elderly and handicapped are found in Brookline (22 percent), West Roxbury (18 percent), and Roslindale (17 percent), while the lowest concentrations are located in Westwood (9 percent), Wellesley (10 percent), and Dover (10 percent). The estimation method assumed that the elderly (over 65 years of age) component of each community's population remained the same between 1970 and 1980 and that the same portion of the under-65 population of each community in the SMSA has a public-transportation disability.[1]

2.1.2 Employment in Study-area Communities

According to MAPC estimates,[2] over 76 percent of all study-area employees worked in the Boston section of the study area in 1980. As indicated in Table 2-3, the only other community which was the work site for more than 20,000 study-area employees in 1980 was Cambridge (the work site for over 12 percent of all of the workers). Dover, the market-area sections of Brookline and Wellesley, Roslindale, and West Roxbury are the work sites for the fewest individuals, with each accounting for less than 4,000 workers.

For those parts of the study area which are in communities that are not included in their entirety in the study area, employment was estimated through zonal assignment of the MAPC estimates (which are no finer than community-level). It was assumed that the employment is distributed among zones within a community in proportion to the 1975 home-based-work-trip attractions estimated by Alan M. Voorhees and Associates, Inc.[3]

Employment by type of work (private, manufacturing, and service), also shown in Table 2-3, was estimated only for those communities included in their entirety in the study area, because this information could not be determined by zone. Needham has the highest (over 90 percent) and Dover the lowest (45 percent) proportion of private-industry employment, while Westwood and Dover have proportionately the most (25 percent) and least (0 percent) manufacturing employees, respectively. Dover employment is the most service-oriented (19 percent), and Dedham has proportionately the fewest service employees (12 percent).

---

[1] Indicated to be 2.1 percent in 1980 in: U. S. Bureau of the Census, Provisional Estimates of Social, Economic, and Housing Characteristics: States and Selected SMSAs, Report No. PHC-80-SI-1, 1982

[2] Metropolitan Area Planning Council, Future Employment Location in Greater Boston: 1980-2010, Preliminary Draft, July 1982

[3] Alan M. Voorhees and Associates, Inc., Eastern Massachusetts Planning Assistance Project computer data files, 1975.

Community	1980 Employment				Total 1985 Employment
	Private	Manufacturing	Service	Total	
Brookline[1]	NA	NA	NA	2,884[3]	3,000[4]
Dedham	10,905	2,176	1,516	12,184	12,300
Dover	296	0	125	653	700
Natick[1]	NA	NA	NA	4,471[3]	4,482[4]
Needham	13,259	3,016	2,121	14,755	14,900
Newton[1]	NA	NA	NA	12,636[3]	13,103[4]
Roslindale	NA	NA	NA	3,253[3]	3,506[5]
Wellesley[1]	NA	NA	NA	2,418[3]	2,550[4]
Westwood	4,528	1,275	944	5,060	5,600
West Roxbury	NA	NA	NA	3,723[3]	3,859[5]
MARKET-AREA TOTAL	NA	NA	NA	62,037	64,000
Boston[2]	NA	NA	NA	416,198[3]	428,633[5]
Cambridge[1]	NA	NA	NA	66,176[3]	68,589[4]
STUDY-AREA TOTAL	NA	NA	NA	544,411	561,222

Notes

[1,2,3,4,5] See following page for notes.

DISTRIBUTION OF 1980 EMPLOYMENT AND PROJECTED 1985 EMPLOYMENT IN MARKET AND STUDY AREAS

Table 2-3 (p.1)

Notes

[1] Only the portion of the community included in the study area

[2] Only the portion of Boston included in the study area but not in the market area

[3] Assumes that 1980 employment is distributed within the community as indicated by the 1975 home-based-work-trip attractions

[4] Assumes that the employment within the selected portion of the community will change at the same rate as the community's total employment

[5] Assumes that the same proportion of 1980-1990 changes in employment will occur by 1985 within all Boston neighborhoods

Sources

a. 1980 Employment and 1985 Employment Forecasts - Metropolitan Area Planning Council, Future Employment Location in Greater Boston: 1980-2010, Preliminary Draft, July, 1982.

b. 1975 Home-Based Work Trips - Alan M. Voorhees and Associates, Inc., Eastern Massachusetts Planning Assistance Project computer data sets, 1975.

Table
2-3
(p.2)

DISTRIBUTION OF 1980 EMPLOYMENT AND PROJECTED 1985 EMPLOYMENT IN MARKET AND STUDY AREAS

MAPC forecasts that study-area employment will grow by about 3 percent between 1980 and 1985. Employment is expected to increase in all of the communities, with Westwood (11 percent), Roslindale (8 percent), and Dover (7 percent) having the largest expected growth. In contrast, Natick, Dedham, and Needham all have expected employment increases of one percent or less.

2.1.3 Income and Auto Ownership in the Market Area

Families in the market area had an average income of about $35,900 in 1980. Mean income by community ranged from $24,800 to $60,600. Between 1.3 and 4.3 percent of the families within a community had incomes below the poverty level. The lowest average income was found in the Roslindale segment of the market area, the highest in Dover. Roslindale and West Roxbury were the only communities in the market area with mean family incomes of under $30,000. Dover and Brookline the only two over $50,000. Table 2-4 summarizes the income and auto-ownership data.

Since the 1980 U. S. Census information on family income was not yet available at the time of work on this project, the mean family incomes were estimated by adjusting the 1970 mean family incomes by tract[1] according to (1) the change in per capita income by town from 1969 to 1977[2] and (2) the increase in the SMSA's Consumer Price Index from 1977 to 1980.

As expected, the percentage of families below poverty level, estimated directly from the 1970 census[3], tended to be largest for the low-income communities, such as Roslindale and Natick, and lowest for the high-income communities, such as Dover. These figures, also presented in Table 2-4, generally indicate a rise in income and a reduction in families below poverty level as the distance between the communities and downtown Boston increases.

There is one automobile per every 1.7 residents in the market area as a whole. In Dover, there is an auto for every 1.5 residents, the highest auto-ownership rate found in the market area. The lowest rate, 1.9 is found in Natick.

Auto-ownership totals for each town were obtained from the 1981 Department of Motor Vehicles registry file. The ownership figures are distributed within the communities outside of Boston according to an address-matched 1981 state motor-vehicle registry

---

[1] U. S. Bureau of the Census, 1970 Census of Population and Housing - Boston, Massachusetts SMSA Census Tracts, Report No. PHC(1)-29, May 1972.

[2] U. S. Bureau of the Census, Current Population Reports, Series P-25, No. 882, June 1980.

[3] U. S. Bureau of the Census, 1970 Census of Population.

Community	FAMILY INCOME 1980 Mean[3]	Percent Below Poverty Level[4]	1981 Auto Ownership
Brookline[1]	51,500	2.5	3,536
Dedham	32,600	3.6	13,594
Dover	60,600	1.3	3,135
Natick[1]	31,700	4.3	4,842
Needham	41,900	2.4	16,955
Newton[1]	48,500	2.5	7,360
Roslindale	24,800	3.7	15,071[5]
Wellesley[1]	41,400	3.7	1,079
Westwood	42,700	2.3	7,820
West Roxbury	28,700	3.3	17,872[5]
MARKET-AREA TOTAL	35,900	3.1	91,264
Boston[2]	22,900	13.8	78,688[5]
Cambridge[1]	25,300	9.4	12,655
STUDY-AREA TOTAL	27,400	9.8	182,607

---

[1] Only the portion of the community that is included in the study area

[2] Only the portion of Boston that is included in the study area but not the market area

[3] Estimated from 1970 mean family income, the increase in per capita income from 1969 to 1977, and the increase in the SMSA's Consumer Price Index from 1977 to 1980

[4] Assumed to be the same as observed in the 1970 census

[5] Assumes that vehicles are distributed within Boston as indicated by the 1970 vehicles per housing unit for each tract

Sources

a. 1970 Family Income and Auto Ownership - U. S. Bureau of the Census, 1970 Census of Population and Housing - Boston, Massachusetts SMSA Census Tracts, Report No. PHC(1)-29, May 1972.
b. 1969 and 1977 per capita income - U. S. Bureau of the Census, Current Population Reports, Series P-25, No. 882, June 1980.
c. 1981 Auto Ownership - 1981 Motor Vehicle Registry File.

DISTRIBUTION OF 1980 INCOME AND 1981
AUTO OWNERSHIP IN MARKET AND STUDY AREAS

Table
2-4

file; vehicles owned by Bostonians are distributed among neighborhoods according to the average number of vehicles per household indicated for each tract in the 1970 census.[1]

2.2 TRAVEL PATTERNS WITHIN THE MARKET AREA

Of the nearly 800,000 trips made daily into, out of, or within the market area in 1975, nearly 165,000 (21 percent) were home-based work trips. The modal split of these trips has changed over time, as ridership on the commuter rail and express-bus services in or near the market area has generally risen over the past few years. The market area, as a whole, produces more trips than it attracts.

2.2.1 Geographical Distribution of Market-area Trips

According to the 1975 trip tables prepared by Alan M. Voorhees and Associates, Inc.,[2] nearly 20 percent of the trips produced and over 20 percent of the trips attracted by communities within the market area are attributable to Needham and Dedham, respectively. As indicated in Table 2-5, Dedham is the only other community which produces over 16 percent of the trips produced in the market area, while Needham and Newton are the only other communities responsible for over 11 percent of all market-area trip attractions.

The figures on home-based work trips presented in Table 2-6 indicate that Needham and Newton are responsible for about 24 and 22 percent of all market-area home-based work-trip attractions, respectively, while over 18 percent of all home-based work trips produced in the market area were made by Roslindale residents. Comparing these and other round-trip figures presented in Table 2-6 with the totals presented in Table 2-5 indicates that about 22 percent of the trips produced within the market area are home-based work trips, while less than 20 percent of the trips attracted to the market area are home-based work trips.

A review of the distribution of trips by attraction and production zones (Table 2-7) indicates that over 17 percent of all trips produced in the market area are attracted to the Boston section of the study area. In contrast, only about 10 percent of the trips produced in the market area are attracted to Needham, the community with the second-highest attraction level.

The work-trip table presented in Table 2-8 indicates that these trips are more concentrated in Boston than other types of travel. Nearly 34 percent of the work trips produced within the market area are attracted by Boston, while about 7.5 and 6 percent are attracted to Needham and Dedham, respectively.

---

[1] Ibid.

[2] Alan M. Voorhees and Associates, Inc., Eastern Mass. Planning Assistance Project.

Community	Trips Produced[3]	Trips Attracted[3]
Brookline[1]	17,516	17,097
Dedham	70,551	75,339
Dover	13,221	4,143
Natick[1]	24,483	25,692
Needham	81,632	72,243
Newton[1]	51,486	66,767
Roslindale	51,059	28,892
Wellesley[1]	6,294	12,558
Westwood	36,824	25,794
West Roxbury	64,435	36,890
MARKET-AREA TOTAL	417,471	365,415
Boston[2]	561,658	1,118,695
Cambridge[1]	114,223	213,674
STUDY-AREA TOTAL	1,093,352	1,697,784

---

[1] Only the portion of the community that is included in the study area

[2] Only the portion of Boston that is included in the study area but not the market area

[3] Trip volumes represent the sum of home-based work, social/recreational, personal business, and school trips and non-home-based trips.

DISTRIBUTION OF '75 TOTAL DAILY TRIPS (ALL MODES)

Table 2-5

Community	Round Trips Produced[3]	Round Trips Attracted[3]
Brookline[1]	1,504	1,630
Dedham	7,287	7,440
Dover	1,327	207
Natick[1]	2,622	2,878
Needham	8,101	8,517
Newton[1]	4,292	7,456
Roslindale	8,656	2,000
Wellesley[1]	446	1,125
Westwood	3,793	2,552
West Roxbury	8,279	2,289
MARKET-AREA TOTAL	46,307	36,094
Boston[2]	76,967	250,210
Cambridge[1]	16,577	38,462
STUDY-AREA TOTAL	139,851	324,766

---

[1] Only the portion of the community that is included in the study area

[2] Only the portion of Boston that is included in the study area but not the market area

[3] Does not include walk trips

DISTRIBUTION OF 1975 HOME-BASED
WORK TRIPS BY ALL MODES (DAILY)

Table
2-6

Production Zone	Attraction Zone Boston*	Brookline**	Cambridge**	Dedham	Dover	Natick**	Needham
Boston*	311,983	2,069	34,641	6,740	58	227	2,592
Brookline**	3,838	3,770	831	439	5	23	320
Cambridge**	35,178	273	28,901	338	10	44	331
Dedham	11,608	483	1,194	26,106	43	129	2,888
Dover	872	37	165	211	1,963	1,522	741
tick**	1,481	43	304	187	161	8,267	794
Needham	8,438	393	1,338	4,036	212	1,103	32,420
Newton**	6,919	739	1,380	1,067	30	119	1,983
Roslindale	19,164	738	1,844	1,504	8	30	658
Wellesley**	533	43	112	138	9	50	608
Westwood	4,386	170	513	3,441	44	117	1,187
West Roxbury	15,774	956	1,809	5,998	17	58	1,803
Outside Study Area	698,521	7,383	140,642	25,134	1,583	14,003	25,918
MARKET-AREA TOTAL	73,013	7,372	9,490	43,127	2,492	11,418	43,402
TOTAL	1,118,695	17,097	213,674	75,339	4,143	25,692	72,243

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*Only the portion of Boston that is included in the study area but not in the market area

**Only the portion of the community that is included in the study area

Table
2-7
(p.1)

DISTRIBUTION OF 1975 DAILY STUDY-AREA TRIPS
BY PRODUCTION AND ATTRACTION ZONES (ALL MODES)

Production Zone	Attraction Zone						
	Newton**	Roslindale	Wellesley**	Westwood	West Roxbury	Outside Study Area	Totals
Boston*	4,153	6,596	491	992	4,498	186,618	561,658
Brookline**	1,177	221	84	61	325	6,422	17,516
Cambridge**	414	399	83	76	401	47,775	114,223
Dedham	1,492	879	349	1,805	3,772	19,803	70,551
Dover	301	28	105	107	68	7,101	13,221
Natick**	304	40	177	63	83	12,579	24,483
Needham	3,560	408	1,430	770	1,495	26,029	81,632
Newton**	17,345	458	441	181	1,185	19,639	51,486
Roslindale	1,533	5,884	111	228	2,547	16,810	51,059
Wellesley**	310	23	1,489	37	56	2,856	6,264
Westwood	450	242	144	10,188	908	15,034	36,824
West Roxbury	4,105	2,980	253	612	10,093	19,977	64,435
Outside Study Area	31,623	10,734	7,401	10,674	11,459	5,996,748	6,981,823
MARKET-AREA TOTAL	30,577	11,163	4,583	14,052	20,532	146,250	417,471
TOTAL	66,767	28,892	12,558	25,794	36,890	6,377,391	8,075,175

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*Only the portion of Boston that is included in the study area but not in the market area

**Only the portion of the community that is included in the study area

Table
2-7
(p.2)

DISTRIBUTION OF 1975 DAILY STUDY-AREA TRIPS
BY PRODUCTION AND ATTRACTION ZONES (ALL MODES)

Production Zone	Attraction Zone Boston*	Brookline**	Cambridge**	Dedham	Dover	Natick**	Needham
Boston*	97,986	392	9,812	1,497	7	64	929
Brookline**	1,349	202	162	58	0	6	66
Cambridge**	13,348	55	7,859	51	1	10	75
Dedham	4,969	84	519	2,692	5	28	730
Dover	347	7	69	59	115	185	172
Natick**	728	13	114	51	13	1,012	185
Needham	4,207	77	536	673	19	202	4,200
Newton**	2,646	92	348	167	2	20	411
Roslindale	8,413	153	866	422	1	12	260
Wellesley**	211	5	37	17	1	6	87
Westwood	2,084	32	223	584	6	26	318
West Roxbury	6,392	155	740	961	4	20	485
Outside Study Area	357,739	1,993	55,638	7,648	240	4,166	9,116
MARKET-AREA TOTAL	31,346	820	3,614	5,684	166	1,517	6,914
TOTAL	500,419	3,260	76,923	14,880	414	5,757	17,034

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*Only the portion of Boston that is included in the study area but not in the market area

**Only the portion of the community that is included in the study area

Table
2-8
(p.1)

DISTRIBUTION OF 1975 DAILY STUDY-AREA TRIPS
BY PRODUCTION AND ATTRACTION ZONES (ALL MODES)

Production Zone	Attraction Zone Newton**	Roslindale	Wellesley**	Westwood	West Roxbury	Outside Study Area	Totals
Boston*	1,128	777	127	278	565	40,372	153,934
Brookline**	148	15	11	12	24	955	3,008
Cambridge**	92	66	15	11	70	11,501	33,154
Dedham	271	77	50	334	256	4,560	14,575
Dover	79	3	16	27	7	1,569	2,655
Natick**	97	9	31	18	19	2,955	5,245
Needham	562	41	159	171	112	5,243	16,202
Newton**	1,509	26	56	35	66	3,206	8,584
Roslindale	413	657	33	79	334	5,669	17,312
Wellesley**	55	2	79	5	3	385	893
Westwood	97	28	21	920	78	3,169	7,586
West Roxbury	704	267	50	135	812	5,834	16,559
Outside Study Area	9,757	2,032	1,602	3,078	2,232	1,291,425	1,746,666
MARKET-AREA TOTAL	3,935	1,125	506	1,736	1,711	33,545	92,619
TOTAL	14,912	4,000	2,250	5,103	4,578	1,376,843	2,026,373

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*Only the portion of Boston that is included in the study area but not in the market area

**Only the portion of the community that is included in the study area

Table
2-8
(p.2)

DISTRIBUTION OF 1975 DAILY STUDY-AREA TRIPS
BY PRODUCTION AND ATTRACTION ZONES (ALL MODES)

It is assumed that trips made between the market area and the study-area segments of Boston and Cambridge are those most likely to be made using the transit service offered in the Forest Hills-Needham corridor. Under this assumption, Tables 2-7 and 2-8 indicate that there were about 82,500 "inbound trips" produced by the market area and attracted to Boston or Cambridge) and 30,800 "outbound trips" (produced in Boston or Cambridge and attracted to the market area) on an average 1975 weekday which could have used the corridor's transit service. About 35,000 of these "inbound trips" and 6,200 of these "outbound trips" were home-based work trips, which are generally made during the peak hours.

2.2.2 Public Transit Service and Ridership

Prior to October 15, 1979, the corridor was serviced by local bus routes which fed the Orange Line station at Forest Hills and by commuter rail service to Needham. Riders in West Roxbury and Hyde Park had the option of taking a local bus to Forest Hills Station or taking commuter rail to downtown Boston. Further away from Boston, commuter rail carried riders into the downtown. Local bus service to Eliot Station on the Green Line's Riverside Branch was also available for travel to Boston from Needham and Wellesley.

As indicated in Table 2-9, ridership on the Needham Branch remained quite steady between 1974 and 1976, but fell to a lower level for the final three years of its operation. The track and rolling stock were deteriorating significantly during this latter time period. A plot of the weekly peak-hour ridership totals for both directions of travel over the last two years of service is presented in Figure 2-2, while trends in the average daily round-trip peak period ridership over the last 22 months of service are shown in Figure 2-3.

Since October 1979, the only public transportation service in the market area (the shaded area in Figure 2-1) has been local and express bus service. Express bus service was designed to fill the void created when Needham Branch commuter rail service was suspended. Local buses had been providing service within the market area before the suspension of rail service and continued afterwards. However, local and express bus trip frequencies and fares have changed since the suspension of rail service. Three major service cutbacks occurred between November 1979 and January 1981; some service has been restored in several phases since April 1981. Fares were raised in August 1981: the base fare on local buses was raised from 25 cents to 50 cents, and on express buses from $1.25 to $1.50.

Two express bus routes to Boston originate from the market area. Route 310 travels from Needham to downtown Boston via the Massachusetts Turnpike, providing service to the people of Needham. Leaving from Needham Junction and proceeding via Needhan Heights or Bird's Hill, these buses travel to Copley

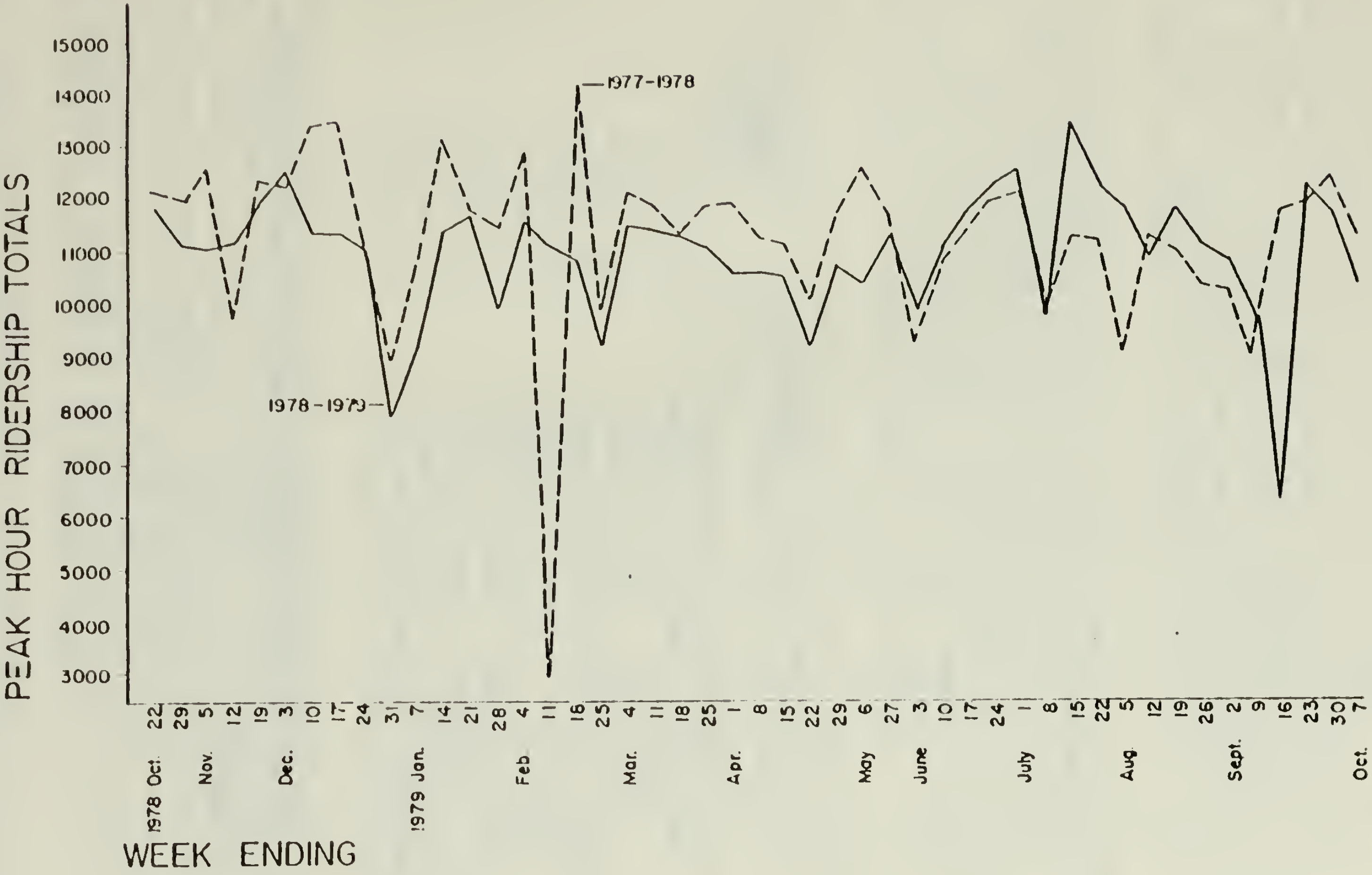
Year	Average Weekday One-Way Ridership	Percent Change From Previous Year
1974	1478	NA
1975	1486	+0.5
1976	1480	-0.4
1977	1407	-4.9
1978	1336	-5.0
1979 (through October)	1407	+5.3

Source:

Jeffrey Paul, Thomas Humphrey, and Yong Chang, Evaluation of Needham Express Bus Service and Framingham Commuter Rail Service, Central Transportation Planning Staff, Technical Report Number 24, June, 1981.

DAILY COMMUTER RAIL RIDERSHIP
ON THE NEEDHAM BRANCH (1974-1979)

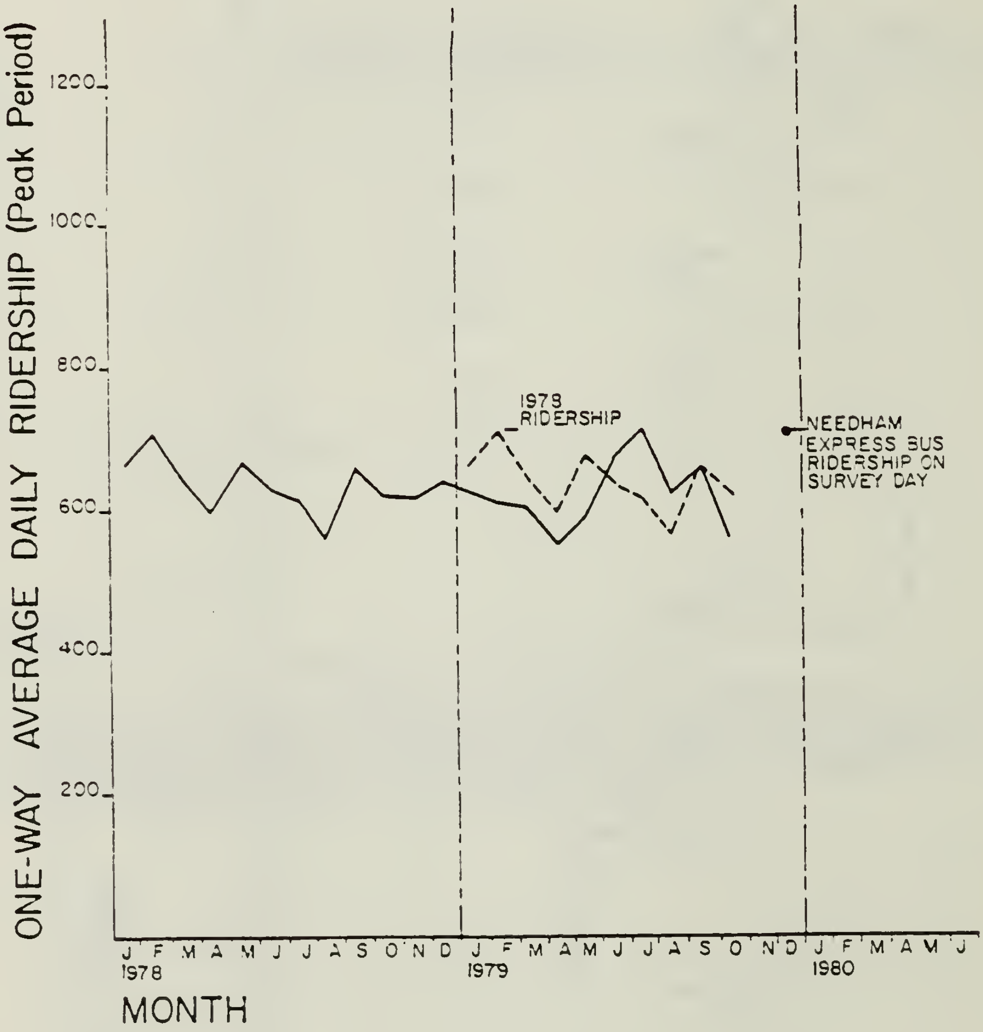
Table
2-9



SOURCE: MBTA Commuter Rail Department (B&M Conductor Counts)

PEAK-HOUR COMMUTER RAIL RIDERSHIP
TRENDS ON THE NEEDHAM BRANCH

Figure
2-2



PEAK-PERIOD COMMUTER RAIL RIDERSHIP
TRENDS ON THE NEEDHAM BRANCH

Figure
2-3

Square and/or to the intersection of Franklin and Devonshire streets. During the off-peak period, Route 310 buses provide service to downtown via Copley Square. There are 48 inbound trips per day. Twenty-five trips are currently run to Boston between 7:00 and 9:00 A.M. During this period, 1,164 riders use the service, according to the last count performed (April 1982). Over the whole day, 1,350 passengers travel to downtown. Scheduled running times from Needham Junction range from 32 minutes for service to Copley Square via Highland Avenue to 42 minutes for service to Franklin and Devonshire streets via Great Plain Avenue. Peak-period ridership on this route has generally risen since its inception. (see Table 2-10).

Residents of Roslindale and West Roxbury use express bus route 315 to travel to Copley Square via the Massachusetts Turnpike. Three trips travel inbound during the 7:00-to-9:00 A.M. period. An additional trip leaves Roslindale Square earlier in the morning. There is no off-peak service; peak service is resumed for outbound trips in the afternoon. One hundred fifty riders travel inbound to Copley Square each day. The travel time from Roslindale Square to Copley Square is 44 minutes.

Local buses within the market area serve the Roslindale and West Roxbury communities. Most routes travel radially from the Forest Hills rapid-transit station. These local bus routes include:

Route 30: Mattapan - Roslindale Square
Route 32: Wolcott Square - Arborway
Route 34: Dedham Line - Arborway
Route 34E: East Walpole - Arborway
Route 35: Dedham Mall/Stimson - Arborway
Route 36: Charles River - Arborway
Route 37: Vermont Street - Arborway
Route 38: Wren Street - Forest Hills Station
Route 40: Georgetowne - Arborway
Route 50: Cleary Square - Arborway
Route 51: Cleveland Circle - Arborway
Route 52: Dedham Mall - Watertown Square

Trip time and service frequency have changed on most of these routes since the commuter rail line was discontinued. A summary of these changes is presented in Table 2-11. About 6,800 riders transfer between the Orange Line's Forest Hills Station and the local bus routes each weekday. Local buses also serve large numbers of trips wholly within the market area. On many routes, the majority of trips occur during the off-peak hours. On the average weekday, a total of 26,600 riders (all directions) use the local bus routes within the market area.

With the temporary discontinuance of Needham Branch service, equipment and train crews became available for use elsewhere. Trains and crews were used on the Framingham Branch of the commuter rail system. Two trains were added during the morning and

Date	Ridership*	Percent Change From Previous Count
OCT 1979	963	--
DEC 1979	705**	-26.2
JAN 1980	801	+13.6
MAR 1980	1162	+45.1
MAY 1981	996	-14.3
AUG 1981	1050	+ 5.4
FEB 1982	1160	+ 0.9
APR 1982	1164	+ 0.3

---

*Peak-hour counts (Downtown and Back Bay)
**CTPS on-board counts

Source: MBTA checker counts

REPLACEMENT BUS RIDERSHIP
(ONE-DAY PEAK-PERIOD COUNTS), 1979-1982

Table
2-10

Route Number	Trip Time (Minutes)	Approximate Frequencies (Minutes)				
		Peak Periods	Day	Night	Saturday	Sunday
30	12	20	30	60	40	60,-
32	15,19[a]	5,20	15,20	30,60	10,13	30,60
34	15	5,7	15,30	30,60	10	30,-
34E	42	15	30	60	30	60
35	23,28[b]	13,12	30	90,60	30	90,-
36	20	6,10	30	45,60	15	45,60
37	15	12,15	30	90,-	30	90,-
38	20,17[c]	15,22	25,40	40,-	23,40	40,-
40	16	45,35	30	-	45,50	-
50	20	20,25	30,60	-	30,60	-
51	30	15,18	30,60	60,120	30,60	-
52	37[d]	30,37	30,45	-	60	-

Note:
A single-number entry indicates no change between 1978 and 1982. Where there are two numbers, the first represents the level in 1978, the second 1982. A hyphen indicates no such service.

[a] The route changed from Cleary Square-Arborway to Wolcott Square-Arborway.
[b] The route changed from Stimson-Arborway to Dedham Mall/Stimson-Arborway.
[c] The route changed from Wren Street-Green Street Station to Wren Street-Forest Hills Station.
[d] The route in 1978 was numbered 533 and included some runs between Charles River Loop and Watertown Square.

Table
2-11

CHANGES IN LOCAL BUS SERVICE:
TRIP TIMES AND FREQUENCIES, 1978-1982

afternoon peak periods of travel. Average weekday ridership counts on the branch are listed in Table 2-12. The counts in the table are from the head counts taken by train crews on all trains inbound or outbound at Back Bay Station. Some market-area residents use the Framingham Branch or the Green Line, but their numbers are few.

In the Boston region, a majority of both express bus and commuter rail users walk to the stop or station at which they board, with walking serving as a more predominant access mode for bus riders. Autos are used more extensively as an access mode (driving alone and parking, carpooling, or being dropped off) by commuter rail riders.

These regional patterns are followed in the Forest Hills-Needham corridor. The survey data presented in Table 2-13 indicates that the majority of all Route 310 and Needham Branch commuter rail riders walked to their boarding stop or station. While the information in Table 2-13 indicates that a greater portion of commuter rail riders walked to their place of boarding, this comparison includes the largely walk-access-oriented rail stations in West Roxbury or Roslindale. When only Needham is considered, as in Table 2-14, the portion of riders accessing stops or stations on foot is greater for bus riders than it was for rail riders. This can be attributed to the relative ease of access to the bus stops, as many individuals who drove or were driven to rail stations choose to walk to bus stops. The percentage of riders driving to Needham stations increased with the switch from rail to bus service because a larger proportion of those who walked to the train found themselves within a significantly shorter distance of a bus stop. Nearly all bus riders access bus stops other than the rail stations on foot.

While these patterns follow expectations, it is suspected that the survey data either underestimates the portion of riders who accessed Needham rail stations by auto or overestimates the portion of Route 310 riders reaching their stops by car. While Table 2-14 indicates that autos are indeed used more extensively as an access mode by Needham rail stations users, it is suspected that the difference is actually more significant.

Finally, although there is no data from which to make estimates, it is expected that nearly all Route 315 and local bus riders access their bus stops by walking. No parking lots are located next to the Route 315 stops, but some riders may park near the stops or access it by local bus. Similarly, local bus riders may park in public parking spaces near stops or transfer from the Orange Line, Green Line, or other bus routes.

Year	Average Weekday Ridership	Percent Change From Previous Year
1974	622	--
1975	621	- 0.1
1976	645	+ 3.9
1977	711	+10.2
1978	811	+14.1
1979	972	+19.9
1980	1337	+37.6
1981	1397	+ 4.5
1982 (average to June)	1553	+11.2

Source: MBTA Commuter Rail Department

DAILY RIDERSHIP ON THE FRAMINGHAM
COMMUTER RAIL LINE (1974-1982)

Table
2-12

		Mode of Access				
Station/Stop	No.[1]	Drive Alone and Park	Carpool	Dropped Off	Walk	Other[2]
		Commuter Rail[3]				
Needham Heights	(58)	9.3%	4.0%	15.5%	71.1%	0%
Needham Center	(82)	10.7	0.9	16.4	70.9	1.1
Needham Junction	(184)	41.4	14.6	13.6	29.0	1.4
Bird's Hill	(179)	25.7	6.6	14.3	52.4	0.9
West Roxbury	(66)	14.1	1.5	16.1	67.1	1.3
Highland	(48)	14.0	5.7	9.6	70.7	0
Bellevue	(38)	4.8	5.2	12.0	78.1	0
Roslindale	(80)	21.5	10.3	7.6	49.5	11.0
TOTAL[4]	(735)	22.9%	7.6%	13.2%	54.2%	2.1%
		Express Bus 310[5]				
Needham Junction	(161)	50.1%	0.7%	13.5%	35.7%	0%
Chestnut	(14)	14.6	0	7.1	78.3	0
Needham Center	(60)	28.6	0	18.0	53.4	0
Gt. Plain-Bradford	(27)	0	0	3.2	96.8	0
Gt. Plain-Wilshire	(39)	0	0	5.2	94.8	0
Bird's Hill	(150)	48.6	0.7	5.4	44.5	0.7
Gt. Plain-South	(21)	0	0	9.8	90.2	0
Highland-May	(8)	36.5	0	0	63.5	0
Higland-Rosemary	(14)	50.3	0	0	49.7	0
Highland-Dana	(6)	0	0	0	100.0	0
Needham Heights	(51)	38.1	0	14.4	47.4	0
Highland-Webster	(21)	23.7	0	14.9	61.4	0
TOTAL[4]	(572)	36.1%	0.4%	9.9%	53.4%	0.2%

---

[1] Number of passengers observed boarding at the station or stop

[2] Includes local bus, taxi, and bicycle

[3] Results of survey conducted as part of the Commuter Rail Improvement Program in November 1976

[4] The percentages on this row indicate the percentage of total ridership observed to use each access mode

[5] Results of CTPS on-board survey for evaluation of Needham express bus service, December 1979

DISTRIBUTION OF COMMUTER RAIL AND EXPRESS
BUS RIDERS BY MODE OF ACCESS TO BOARDING STATION
OR STOP (BASE DATA)

Table
2-13

	Mode of Access				
Access Point	Drive Alone and Park	Carpool	Dropped Off	Walk	Other[1]
Needham rail stations[2]	27.9%	8.8%	14.4%	47.8%	1.1%
Needham bus stations[3]	45.0	0.4	11.4	42.9	0.2
Needham bus stops[4]	10.9	0.0	5.7	83.3	0.0
Needham bus stops and stations[5]	36.1	0.4	9.9	53.4	0.2

---

[1] Includes local bus, taxi, and bicycle.

[2] Persons boarding commuter trains at Needham rail stations. Based on results of survey conducted as part of the Commuter Rail Improvement Program in November 1976

[3] Persons boarding Route 310 express bus at Needham bus stops which formerly served as commuter rail stations. Based on results of CTPS on-board survey conducted for evaluation of Needham express bus service in December 1979

[4] Persons boarding Route 310 express bus at Needham bus stops which did not formerly serve as commuter rail stations. Based on results of the December 1979 on-board survey

[5] Persons boarding Route 310 expres bus at any Needham bus stop (includes those stops which formerly served as commuter rail stations). Based on results of the December 1979 on-board survey

DISTRIBUTION OF MODES OF ACCESS
TO NEEDHAM COMMUTER RAIL STATIONS
AND EXPRESS BUS STOPS (BASE DATA)

Table
2-14

3.0 PROCEDURE FOR FORECASTING RIDERSHIP

The level of transit ridership generated in the market area depends upon the total demand for travel of all types by those living or working in the area and the percentage of that total that use transit as opposed to a competing mode, such as private automobile. As a result, the changes expected in both of these factors (trips generated and modal share) must be estimated in order to forecast transit ridership.

As indicated in Figure 3-1, such a procedure is followed in projecting 1985 ridership for the three transit-service alternatives. First, previously calibrated formulae are used with estimates of 1975 travel to estimate the total number of trips produced and attracted by each of the zones in the study area in 1985.[1] Next, pivot-point analysis is used to forecast changes in the share of trips made using transit over the 1975-1985 period and in transit ridership over the time periods between the source surveys and 1985. This analysis is described in Sections 3.2 and 3.3. The framework of this forecasting procedure is presented below, along with details concerning the data sources and assumptions used in making the ridership forecasts. The procedure was selected to obtain estimates quickly while satisfying budgetary constraints.

It should be noted that since the forecasts are based on surveys taken during different time periods, the express bus ridership forecasts assume a higher level of service on the Framingham commuter rail branch than do the commuter rail ridership forecasts, which assume that Framingham branch service will be cut back to September 1979 levels if the Needham branch is reopened.

3.1 FORECASTING TRIP GENERATIONS

An analysis of trip generation conducted in 1963 as part of the Eastern Massachusetts Regional Planning Project (EMRPP), indicated that the total number of trips made within the region (all modes) was a function of population, employment, automobile ownership, school enrollment, the number of college students,

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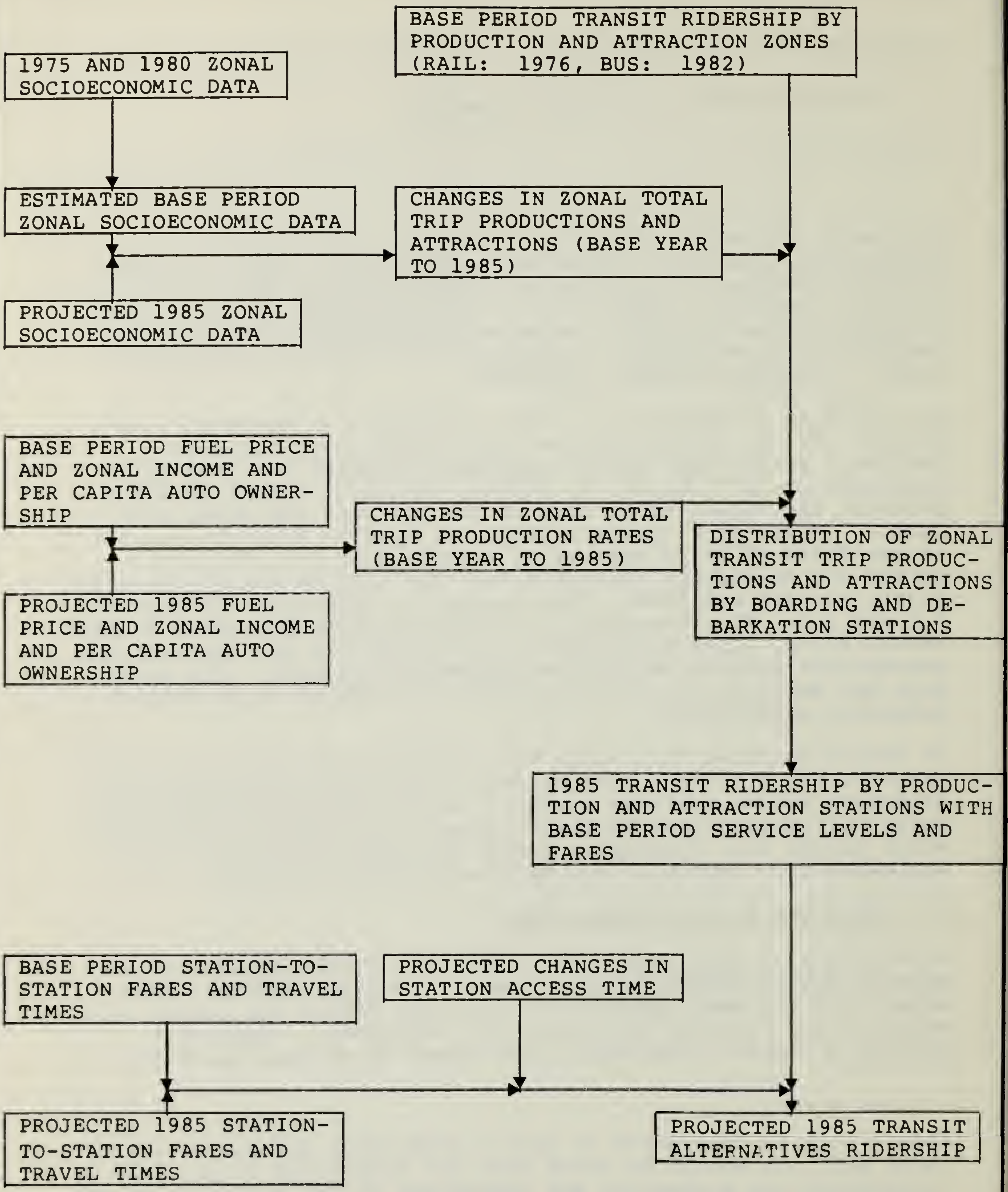
[1] Every trip is considered to have a production end and an attraction end. It should be noted that for home-based trips, home is considered the production end regardless of the direction of the trip.


BASE PERIOD TRANSIT RIDERSHIP BY PRODUCTION AND ATTRACTION ZONES (RAIL: 1976, BUS: 1982)
1975 AND 1980 ZONAL SOCIOECONOMIC DATA
ESTIMATED BASE PERIOD ZONAL SOCIOECONOMIC DATA
CHANGES IN ZONAL TOTAL TRIP PRODUCTIONS AND ATTRACTIONS (BASE YEAR TO 1985)
PROJECTED 1985 ZONAL SOCIOECONOMIC DATA
BASE PERIOD FUEL PRICE AND ZONAL INCOME AND PER CAPITA AUTO OWNERSHIP
CHANGES IN ZONAL TOTAL TRIP PRODUCTION RATES (BASE YEAR TO 1985)
DISTRIBUTION OF ZONAL TRANSIT TRIP PRODUCTIONS AND ATTRACTIONS BY BOARDING AND DEBARKATION STATIONS
PROJECTED 1985 FUEL PRICE AND ZONAL INCOME AND PER CAPITA AUTO OWNERSHIP
1985 TRANSIT RIDERSHIP BY PRODUCTION AND ATTRACTION STATIONS WITH BASE PERIOD SERVICE LEVELS AND FARES
BASE PERIOD STATION-TO-STATION FARES AND TRAVEL TIMES
PROJECTED CHANGES IN STATION ACCESS TIME
PROJECTED 1985 STATION-TO-STATION FARES AND TRAVEL TIMES
PROJECTED 1985 TRANSIT ALTERNATIVES RIDERSHIP

PROCEDURE FOR FORECASTING
TRANSIT-ALTERNATIVE RIDERSHIP

Figure 3-1

type of area, and purpose of trip. In 1975, as part of the Eastern Massachusetts Planning Assistance Project (EMPAP), Alan M. Voorhees Associates used EMRPP formulae for the estimation of trips produced by and attracted to a zone by the type of area (rural, suburban, urban, or CBD) and purpose of trip (work, personal business, social and recreational, school, or non-home-based). These formulae are presented in Table 3-1.

As indicated in Table 3-1, zonal population is perhaps the most significant variable in estimating trip productions and attractions. All CBD and urban trip-production volumes; suburban and rural work and non-home-based trip-production volumes; and all personal-business, social-and-recreational, and non-home-based trip-attraction volumes are a function of zonal population. Suburban and rural personal-business and social-and-recrational trip-production volumes are estimated as a function of zonal auto registrations; suburban and rural school trip-production volumes are a function of zonal residents attending school; CBD school trip attractions are proportional to the number of students attending zonal schools of higher education; and non-home-based trip-production volumes and nearly all trip-attraction volumes are functions of zonal employment levels.

The zonal structure used in this study is defined in Table 3-2 and Figures 3-2 and 3-3. The market area is made up of Zones 1-18 and 24-29, while Zones 30-46 are added to complete the study area.

The EMRPP formulae were used in this study to forecast total future-year zonal trip productions and attractions (all modes), based on estimated and forecasted levels of zonal population, automobile registrations, employment, and school enrollment. While 1975 population estimates by zone are obtained from the Voorhees study[1], zonal populations for 1980 are taken from the U. S. Census.[2] The 1985 population projections are based upon MAPC town and Boston-neighborhood forecasts[3], assuming all zonal populations within a community change at the same rate and all Boston-neighborhood populations change at a constant rate between 1980 and 1990. The resultant population estimates are presented in Table 3-3.

Also listed in Table 3-3 are the expected levels of employment in the study area. Zonal estimates of 1975 employment are obtained from the Voorhees EMPAP work mentioned earlier. Zonal employment

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[1] Alan M. Voorhees and Associates, Inc. Eastern Massachusetts Planning Assistance Project computer data files, 1975.

[2] U. S. Bureau of the Census, Census of Population and Housing - Population Counts, P. L. 94-171, 1980.

[3] Metropolitan Area Planning Council, Regional Decline or Revival, 1982.

Type of Area

Work Trips Produced

CBD: WKPRD = 0.562*POP
URBAN: = 0.559*POP
SUBURBAN: = 0.542*POP
RURAL: = 0.493*POP

Personal Business Trips Produced

CBD: PBPRD = 0.430*POP
URB: = 0.361*POP
SUB: = 2.012*CARS
RUR: = 1.912*CARS

Social and Recreational Trips Produced

CBD: SRPRD = 0.201*POP
URB: = 0.202*POP
SUB: = 1.001*CARS
RUR: = 0.926*CARS

School Trips Produced

CBD: SCHPRD = 0.121*POP
URB: = 0.109*POP
SUB: = 0.778*K8&HGH
RUR: = 1.266*K8&HGH

Non-Home-Based Trips Produced

CBD: NHBPRD = 0.354*MFGOTH+0.605*RSCFIR+0.187*POP
URB: = 0.249*MFGOTH+0.748*RSCFIR+0.139*POP
SUB: = 0.343*MFGOTH+1.789*RSCFIR+0.151*POP
RUR: = 0.317*MFGOTH+2.288*RSCFIR+0.154*POP

Work Trips Attracted

CBD: WKATT = 0.941*MFGOTH+1.605*RSCFIR
URB: = 1.310*MFGOTH+1.325*RSCFIR
SUB: = 1.216*MFGOTH+1.582*RSCFIR
RUR: = 1.123*MFGOTH+1.880*RSCFIR

Personal Business Trips Attracted

CBD: PBATT = 3.904*RETAIL+0.187*POP
URB: = 0.869*RSCFIR+0.179*POP
SUB: = 3.804*RSCFIR+0.153*POP
RUR: = 6.124*RSCFIR+0.127*POP

FORMULAE FOR ESTIMATING PERSON-TRIP
PRODUCTIONS AND ATTRACTIONS

Table
3-1
(p.1)

Type of Area

Social and Recreational Trips Attracted

CBD: SRATT = 0.324*RETAIL+0.225*POP
URB: = 0.369*RSCFIR+0.140*POP
SUB: = 0.902*RSCFIR+0.191*POP
RUR: = 1.232*RSCFIR+0.194*POP

School Trips Attracted

CBD: SCHATT = 1.810*COL
URB: = 1.024*RSCFIR
SUB: = 1.082*RSCFIR
RUR: = 2.440*RSCFIR

Non-Home-Based Trips Attracted

CBD: NHBATT = 0.335*MFGOTH+0.553*RSCFIR+0.234*POP
URB: = 0.206*MFGOTH+0.677*RSCFIR+0.155*POP
SUB: = 0.280*MFGOTH+1.627*RSCFIR+0.182*POP
RUR: = 0.274*MFGOTH+2.368*RSCFIR+0.158*POP

Notes:

POP = population, by place of residence

CARS = number of automobiles

K8&HGH = school enrollment in grades kindergarten through 12, by place of residence

MFGOTH = manufacturing and other employment, including construction, wholesale, transportation, communications, utilities, government, mining, farming, and fisheries (Standard Industrial Classification Codes 01-50, 91-99), by place of employment

RSCFIR = retail, service, finance, insurance, and real estate employment (S.I.C. Codes 52-89), by place of employment

RETAIL = retail employment (S.I.C. Codes 52-59), by place of employment

COL = college and other post-high school enrollment, by place of attendance

FORMULAS FOR ESTIMATING PERSON-TRIP PRODUCTIONS AND ATTRACTIONS

Table 3-1 (p.2)

Study Zone	Community	CTPS Zone(s)
1	Needham	432
2	Needham	433
3	Needham	434
4	Needham	435
5	Needham	436
6	West Roxbury*	175
7	West Roxbury*	176
8	West Roxbury*	177
9	West Roxbury*	178
10	Roslindale*	163
11	Roslindale*	164
12	Roslindale*	165
13	Roslindale*	166
14	Roslindale*	167
15	Brookline	256
16	Newton	352
17	Newton	353
18	Wellesley	426
24	Natick	512
25	Dover	521

DEFINITION OF STUDY-AREA ZONAL STRUCTURE

Tabl
3-2
(p.1

Study Zone	Community	CTPS Zone(s)
26	Westwood	442
27	Westwood	443
28	Dedham	440
29	Dedham	441
30	Hyde Park*	179-184
31	Roxbury*	99-105, 111-130, 161
32	Jamaica Plain*	110, 162, 168-174
33	Fenway-Parker Hill*	95-98, 106-109
34	South Boston*	81-94
35	South End*	34, 36, 44-52, 55-60
36	Prudential Center*	35, 37-43
37	Back Bay*	29-32
38	Park Square*	2, 33, 53-54
39	Financial-Retail*	1, 4-6, 11, 13
40	Government Center*	3, 9, 10, 12, 20-22
41	Beacon Hill*	24, 26-28
42	North End*	15-19, 23, 25
43	Waterfront*	7, 8, 14
44	Kendall Square**	200, 202-203, 210
45	Central Square**	204, 209, 211-213
46	Harvard Square**	214-220

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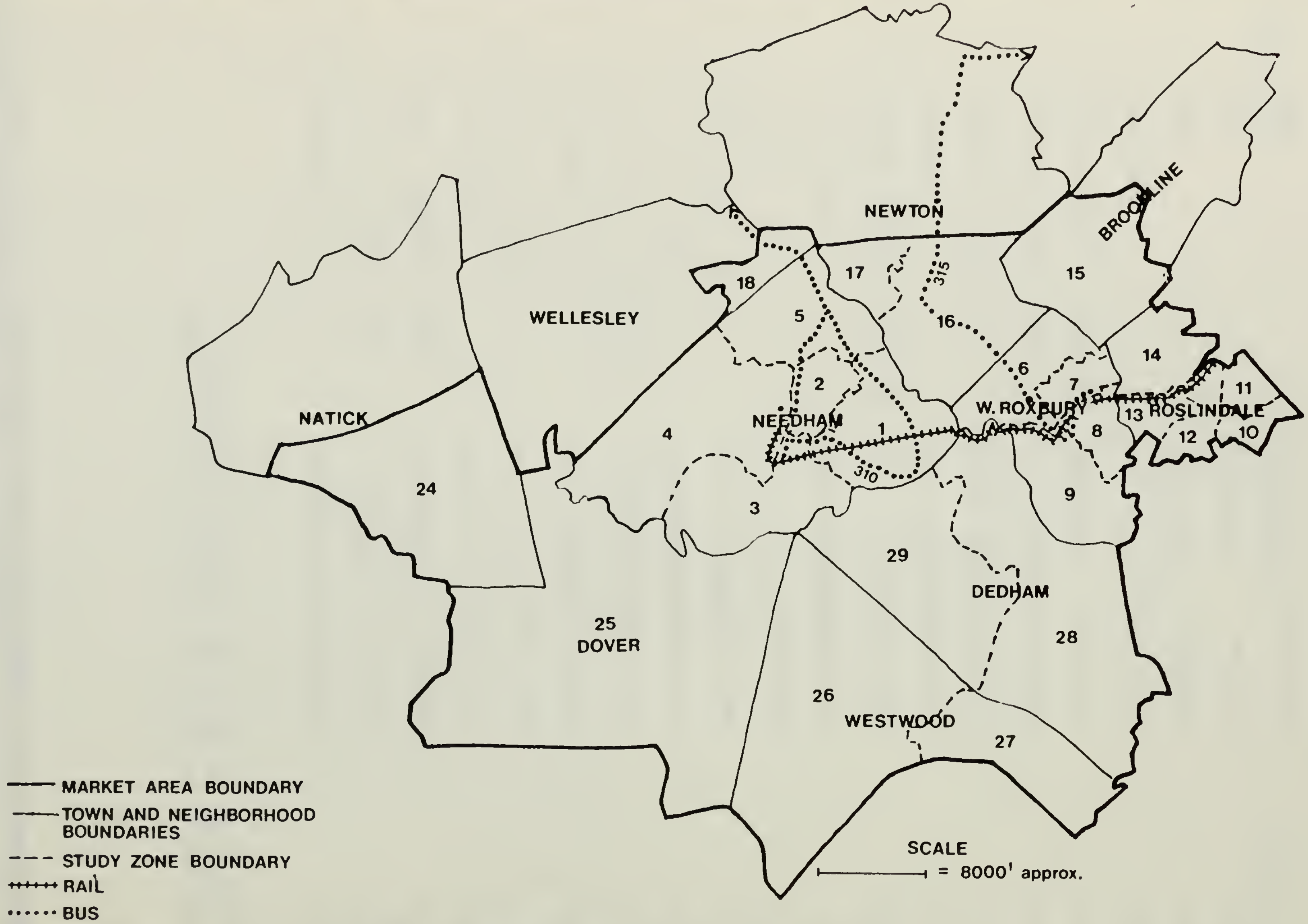
*Neighborhood is part of the City of Boston
**Neighborhood is part of the City of Cambridge

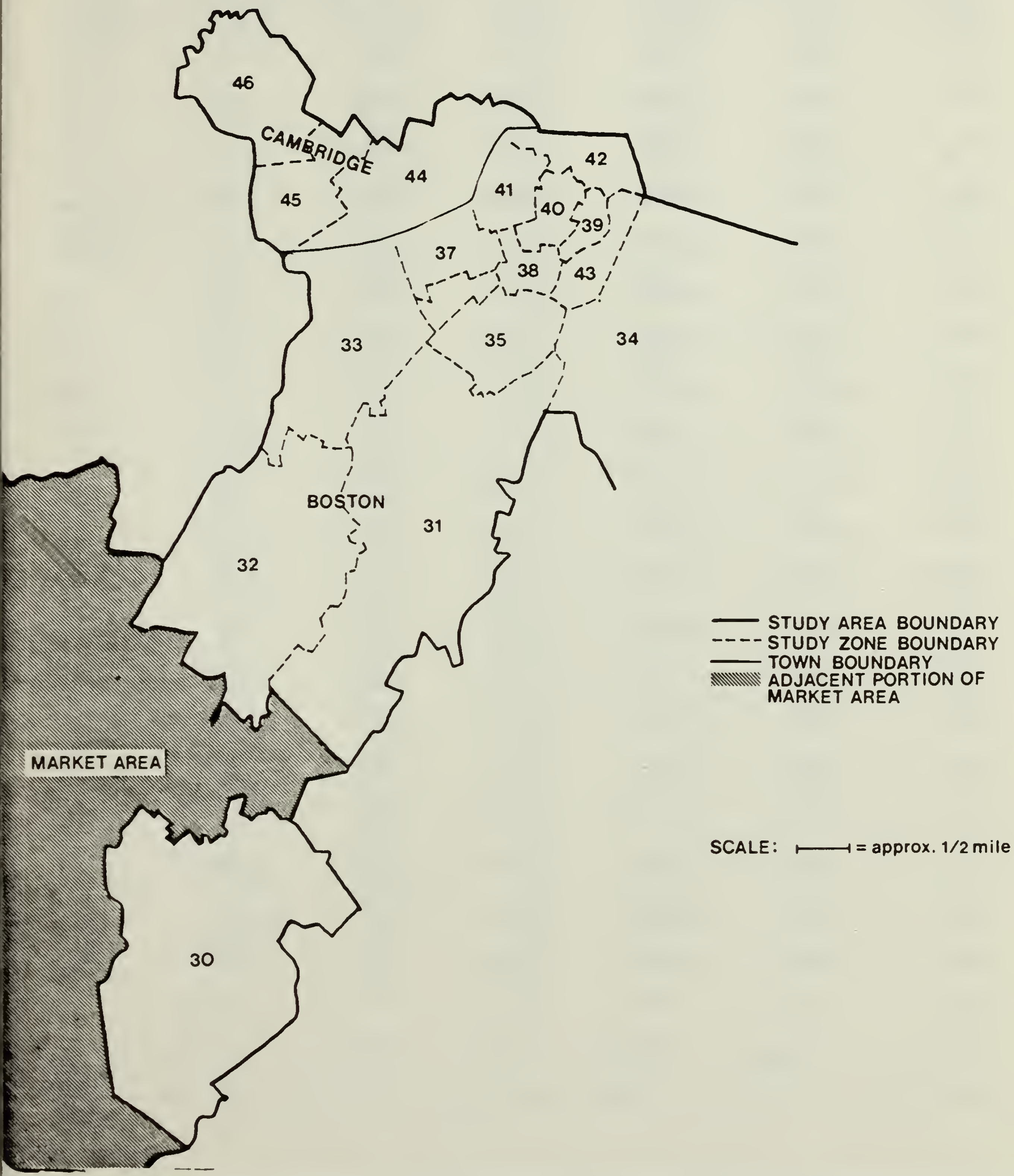
DEFINITION OF STUDY-AREA ZONAL STRUCTURE

Table 3-2 (p.2)



COMMUTER RAIL AND EXPRESS BUS ROUTES
AND STUDY ZONES FOR THE MARKET AREA

Figure
3-2



ZONAL STRUCTURE OF STUDY AREA OUTSIDE OF MARKET AREA

Figure 3-3

Study	Estimated Population			Estimated Employment		
Zone	1975	1980	1985	1975	1980	1985
1	7,951	6,915	6,915	2,055	2,257	2,279
2	4,711	4,160	4,160	1,480	1,761	1,778
3	4,286	3,990	3,990	1,544	1,777	1,794
4	7,324	7,697	7,696	2,904	3,223	3,255
5	5,625	5,139	5,139	5,463	5,737	5,794
6	6,001	6,509	6,076	497	529	545
7	6,108	5,160	4,817	422	472	487
8	6,084	5,075	4,737	611	667	688
9	12,363	12,049	11,247	1,881	2,054	2,117
10	2,172	1,727	1,644	268	291	300
11	2,551	2,128	2,025	565	584	602
12	8,174	7,475	7,114	1,015	1,051	1,083
13	8,660	7,836	7,458	621	646	666
14	9,780	8,797	8,373	646	681	702
15	5,550	5,975	5,807	2,440	2,884	3,000
16	11,897	9,895	9,608	6,078	7,122	7,385
17	3,944	3,560	3,457	5,254	5,514	5,718
18	1,648	1,788	1,787	1,598	2,418	2,550
24	9,678	9,056	9,068	4,522	4,471	4,482
25	4,899	4,703	4,700	325	653	700

ZONAL DISTRIBUTION OF STUDY-AREA
POPULATION AND EMPLOYMENT

Table
3-3
(p.1)

Study	Estimated Population			Estimated Employment		
Zone	1975	1980	1985	1975	1980	1985
26	8,374	8,290	8,282	2,450	3,175	3,514
27	5,624	4,922	4,918	1,553	1,885	2,086
28	23,977	22,219	22,221	7,588	8,101	8,178
29	2,920	3,079	3,079	3,602	4,083	4,122
MARKET-AREA TOTAL	170,301	158,144	154,318	55,382	62,036	63,825
30	37,486	32,526	31,237	6,654	6,798	7,058
31	69,630	53,641	53,075	21,062	21,410	22,206
32	41,275	37,384	35,894	8,574	8,751	9,110
33	47,012	43,706	43,963	45,000	45,955	47,263
34	37,701	31,012	30,502	28,602	29,133	30,231
35	17,391	20,949	21,191	13,069	13,364	13,738
36	4,853	4,810	4,838	40,906	44,582	45,851
37	13,395	13,526	13,605	21,323	22,973	23,627
38	2,797	6,664	6,703	34,593	38,120	39,205
39	529	1,998	2,010	57,930	64,356	66,187
40	1,962	2,832	3,193	51,542	49,585	50,984
41	11,836	14,894	14,797	18,795	21,546	22,148
42	10,167	8,807	9,931	39,194	39,189	40,295
43	365	300	300	12,088	10,436	10,730
44	12,636	12,071	11,739	33,526	36,103	37,420
45	16,609	14,584	14,183	9,892	10,652	11,040
46	30,079	29,308	28,502	17,988	19,421	20,129
STUDY-AREA TOTAL	526,024	487,156	479,981	516,120	544,410	561,047

ZONAL DISTRIBUTION OF STUDY-AREA
POPULATION AND EMPLOYMENT

Table
3-3
(p.2)

in 1980 and 1985 is estimated from the forecasts prepared by the MAPC at the town and Boston-neighborhood level[1], assuming that employment levels change at the same rate within all the zones in a community and all Boston-neighborhood employment levels change at a constant rate between 1980 and 1990. The distribution of total employment in a zone by type (manufacturing and other; service, finance, insurance, and real estate; or retail) is assumed to remain proportionally the same throughout the period.

While estimates of the distribution of 1975 automobile registrations among the zones within a city or town are obtained from the aforementioned Voorhees EMPAP work, 1975 and 1981 auto ownership totals for each town are obtained from the Department of Motor Vehicles registry files. The 1981 registration estimates are distributed among the zones within the communities outside of Boston in the same proportions as in an address-matched 1981 registry file prepared by CTPS, while vehicles owned by Bostonians are distributed among the neighborhoods according to the product of the average number of vehicles per household indicated for the tracts within the neighborhood in the 1970 census[2] and the number of 1980 households. The number of vehicles owned by the residents of each town in 1980 and 1985 are estimated according to the assumption that the per-capita automobile registrations within a town continue to change throughout the 1975-1985 period at the annual proportional rate indicated by a comparison of the 1975 and 1981 ownership and population estimates. These ownership figures are then distributed among the zones within the town in proportion to the 1981 estimates. The results of this procedure are presented in Table 3-4. Some of these estimates disagree with the historical excise-tax records within the individual towns. However, the Department of Motor Vehicles registry file was selected for use since it was a single, edited, consistent data set available for all towns throughout the period of time under study.

Also listed in Table 3-4 are the estimated levels of school enrollment (kindergarten through high school) for each of the zones in 1975, 1980, and 1985. The 1975 zonal estimates are obtained from the aforementioned Voorhees EMPAP work, and the per-capita enrollment within each zone is assumed to change at the annual

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[1] Metropolitan Area Planning Council, Future Employment Location in Greater Boston: 1980-2010, Preliminary Draft, July 1982.

[2] U. S. Bureau of the Census, 1970 Census of Population and Housing - Boston, Massachusetts SMSA Census Tracts, Report No. PHC(1)-29, May 1972

Study Zone	Automobile Registrations 1975	1980	1985	School Enrollment 1975	1980	1985
1	5,343	3,927	3,489	2,063	1,505	1,176
2	3,123	2,496	2,255	1,222	891	697
3	2,880	2,454	2,246	1,149	840	655
4	4,912	4,349	4,010	1,894	1,382	1,080
5	3,524	4,123	4,109	1,359	991	776
6	3,257	4,048	3,987	1,074	835	703
7	3,164	3,377	3,226	1,233	959	807
8	3,047	3,328	3,194	1,324	1,030	867
9	6,189	6,723	6,446	2,207	1,717	1,444
10	1,020	801	719	314	243	205
11	1,231	1,197	1,122	528	411	345
12	3,370	3,819	3,693	1,623	1,262	1,061
13	3,665	3,889	3,711	1,720	1,337	1,125
14	4,539	5,138	4,967	1,847	1,436	1,207
15	3,746	3,570	3,477	918	870	859
16	8,546	5,528	4,675	2,524	1,941	1,545
17	2,004	2,242	2,116	682	524	417
18	1,169	1,094	1,017	350	265	195
24	3,400	4,565	4,465	2,363	1,772	1,263
25	3,490	3,192	2,998	1,304	1,044	871

ZONAL DISTRIBUTION OF STUDY-AREA AUTOMOBILE
REGISTRATIONS AND SCHOOL ENROLLMENT

Table
3-4
(p.1)

Study Zone	Automobile Registrations 1975	1980	1985	School Enrollment 1975	1980	1985
26	5,542	4,959	4,599	2,265	1,723	1,385
27	3,422	3,041	2,817	1,419	1,078	868
28	13,620	12,159	11,056	5,546	3,929	2,959
29	2,491	1,819	1,589	802	567	428
MARKET-AREA TOTAL	96,694	91,838	85,983	37,730	28,552	22,938
30	16,991	17,901	17,057	8,233	6,401	5,383
31	13,388	12,314	11,419	15,214	11,829	9,947
32	12,953	13,370	12,688	8,053	6,261	5,265
33	11,406	11,023	10,324	2,982	2,319	1,950
34	9,896	8,538	7,831	7,874	6,122	5,148
35	3,981	3,461	3,174	2,519	1,959	1,647
36	1,367	1,070	961	195	152	127
37	5,153	3,839	3,413	209	162	137
38	563	972	1,022	292	227	191
39	161	276	290	30	23	20
40	748	619	562	93	72	61
41	5,000	3,948	3,551	394	306	258
42	2,166	1,921	1,768	1,344	1,045	879
43	145	140	140	32	25	21
44	2,925	2,699	2,462	1,679	1,438	1,498
45	6,013	4,016	3,435	2,071	1,774	1,848
46	11,789	6,988	5,835	1,687	1,445	1,505
STUDY-AREA TOTAL	201,339	184,933	171,915	90,631	70,112	58,823

ZONAL DISTRIBUTION OF STUDY-AREA AUTOMOBILE REGISTRATIONS AND SCHOOL ENROLLMENT

Table 3-4 (p.2)

proportional rate indicated at the town level from a comparison of Massachusetts Department of Education enrollment reports for the 1975-1976 and 1981-1982 school years.[1]

Using these estimated changes in the socioeconomic characteristics of the zones, the total trip production and attraction volumes (all modes) for 1975, 1980, and 1985 are estimated to be of the levels presented in Table 3-5.

3.2 FORECASTING TRANSIT RIDERSHIP: THE DEMOGRAPHIC AND GASOLINE-COST FACTORS

A number of factors influence the split of total trips among the available modes of transport. The factors which can produce the most significant modal shifts include changes in:

(1) the levels of service offered by the alternative modes (i.e., frequency of service, access time, and in-vehicle travel time),
(2) the out-of-pocket costs of using the alternative modes (i.e., fares charged and gasoline costs),
(3) personal income, and
(4) automobile ownership.

Changes in these factors over the 1975-1980 and 1980-1985 periods were thus estimated and forecast, respectively, in order to forecast the ridership for each transit alternative in 1985. Factors (3) and (4), and gasoline cost are considered in this section, yielding what we shall call intermediate forecasts. Factor (1) and fares are considered in Section 3.3.

First, ridership forecasts are made in the form of productions and attractions for commuter rail and local and express buses in 1985, assuming that transit fares and service remain at the same levels as during the period in which the ridership volumes used as the base for making the forecasts were observed. These intermediate forecasts of zonal transit trip productions and attractions were made as a function of:

(1) changes expected in the total volume of trips by all modes produced and attracted by the zone as a result of MAPC population and employment forecasts,
(2) assumed changes in the price of gasoline, per-capita income, and per-capica automobile ownership, and
(3) the elasticity of transit ridership with respect to fuel price, personal income, and automobile ownership.

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[1] Massachusetts Department of Education, Division of Research, Planning and Evaluation, "Public School Enrollments by Grade - 1975-1976," December 13, 1976; and Massachusetts Department of Education, Bureau of Data Collection, "Individual School Report, October 1, 1981.

Zone	Productions 1975	Productions 1980	Productions 1985	Attractions 1975	Attractions 1980	Attractions 1985
1	20,664	16,611	15,497	13,161	12,630	12,719
2	12,958	11,365	10,739	12,040	12,653	12,755
3	11,895	10,864	10,315	10,849	11,300	11,389
4	19,951	19,020	18,127	16,670	17,355	17,492
5	16,164	17,335	17,036	19,523	19,387	19,551
6	12,723	14,725	14,203	5,741	5,665	5,504
7	12,879	12,595	11,925	6,818	6,038	5,934
8	12,709	12,506	11,872	6,910	6,073	6,005
9	26,124	26,991	25,673	17,421	16,725	16,620
10	4,334	3,519	3,258	2,832	2,482	2,488
11	3,828	3,278	3,144	3,228	2,857	2,865
12	11,607	10,695	10,214	6,821	6,053	5,957
13	12,202	11,118	10,612	6,621	5,731	5,613
14	19,088	19,514	18,684	9,390	8,186	8,071
15	17,516	17,868	17,621	17,097	18,610	19,144
16	39,504	31,581	29,299	46,684	49,103	50,613
17	11,982	12,492	11,383	20,083	20,047	20,665
18	6,264	7,408	7,359	12,558	16,998	17,873
24	24,483	28,326	27,809	25,692	24,390	24,439
25	13,221	12,549	12,042	4,143	5,109	5,296

ZONAL DISTRIBUTION OF TRIP PRODUCTION
AND ATTRACTION VOLUMES (ALL MODES)

Table
3-5
(p.1)

Zone	Productions 1975	Productions 1980	Productions 1985	Attractions 1975	Attractions 1980	Attractions 1985
26	22,748	21,848	21,175	16,724	19,021	20,587
27	14,076	12,826	12,352	9,070	9,387	10,109
28	57,819	53,173	50,255	50,303	48,489	48,942
29	12,732	11,898	9,203	25,036	26,495	26,734
MARKET-AREA TOTAL	417,471	400,105	379,797	365,415	370,784	377,265
30	67,091	57,305	55,243	41,602	30,178	30,132
31	103,010	81,667	81,210	83,181	71,896	73,355
32	60,466	55,420	53,570	45,143	41,293	41,073
33	91,265	87,996	89,107	171,310	165,714	169,963
34	63,441	55,732	55,159	89,455	84,574	86,960
35	30,039	30,739	31,494	40,967	44,037	45,107
36	28,699	30,447	33,609	90,073	129,011	132,634
37	30,632	28,957	30,310	72,241	79,657	81,780
38	22,421	26,406	28,289	79,533	97,976	100,650
39	31,628	37,218	42,891	146,881	185,116	190,360
40	26,678	26,690	27,187	92,574	100,550	103,413
41	27,963	28,146	29,495	54,309	66,133	67,611
42	32,694	28,327	29,903	91,664	102,691	106,074
43	5,540	4,560	4,103	23,071	23,485	24,147
44	33,662	34,021	34,726	96,852	101,105	104,426
45	27,705	25,441	25,162	36,955	36,608	37,500
46	52,856	52,669	52,475	79,867	80,916	82,978
STUDY-AREA TOTAL	1,153,261	1,091,846	1,083,730	1,701,093	1,811,724	1,855,428

ZONAL DISTRIBUTION OF TRIP PRODUCTION
AND ATTRACTION VOLUMES (ALL MODES)

Table
3-5
(p.2)

Without a change in the modal distribution of trips, transit ridership would be expected to change in proportion to the total number of trips produced and attracted by zones in the study area served by transit. The forecast of these 1980 and 1985 trip volumes has been discussed in Section 3.1. Furthermore, zonal productions and attractions are assumed to change at a constant proportional rate throughout the 1975-1980 and 1980-1985 periods. For example, $P_{i,1978}$, the volume of trips produced in zone "i" in 1978, is estimated as indicated below in Equation 1. The ratio of 1980 and 1975 production rates is raised to the .6 power because in 1978 the 1975-1980 time period was three-fifths complete.

$$P_{i,1978} = \left(\frac{P_{i,1980}}{P_{i,1975}}\right)^{.6} (P_{i,1975}) \quad (1)$$

Transit ridership tends to increase when gasoline prices rise, as such price increases are felt most sharply by automobile drivers, thus causing some to switch from automobile to transit. Empirical observations indicate that the point elasticity of transit ridership to the real price of gasoline (the absolute price(s) of fuel divided by the Consumer Price Index) is .035.[1] This means that each one-percent increase in the real price of gasoline is expected to lead to an increase in transit ridership of about .035 percent. The price of gasoline in Boston is assumed to increase in real terms between 1982 and 1985 at the same rate as from 1979 to 1982.[2]

An increase in personal income tends to reduce transit ridership, as it permits travelers to use the more expensive private modes (taxi or automobile) of transportation with a greater frequency. Disaggregate models calibrated from survey data indicate that point elasticities for bus and rail ridership with respect to personal income are about -.25 and -.29, respectively.[3] In other words, each real one-percent increase in personal income can be expected to lead to .25- and .29-percent reductions in bus and rail ridership, respectively.

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[1] John Pucher and Jerome Rothenberg, Pricing in Urban Transportation: A Survey of Empirical Evidence on the Elasticity of Travel Demand, MIT Department of Economics, July 1976.

[2] Historical fuel prices in Boston are as reported in: Benjamin Dansker, Charles Kalauskas and Deborah Schreiber, "Measures of the Impacts of Changes in Motor Fuel Supply in Massachusetts," Energy: Forecasting, Data, and Conservation, Transportation Research Record 801, National Academy of Sciences, 1981.

[3] Pucher and Rothenberg.

Historical per-capita income estimates are taken from U. S. Census reports,[1] with per-capita income assumed to remain constant in real terms from 1980 to 1985. The income and gasoline-price estimates are presented in Table 3-6.

Finally, an increase in the number of automobiles owned by a household increases the number of household trips made by automobile, thus reducing transit ridership. Analysis of the results of a Department of Transportation study[2] indicates the long-run point elasticity of transit ridership to automobile ownership (from a comparison of transit use among one-car, two-car, and three-car households, taking into account estimated differences in income) is about -.6. In other words, each one-percent increase in per-capita automobile registrations is expected to reduce transit ridership by about six-tenths of a percent. As with the zonal volumes of trip productions and attractions, the per-capita automobile-registration rate is assumed to change within a zone at a constant proportional rate. The source of the auto-ownership estimates is discussed in Section 3.1.

Taking the above four factors into account, the intermediate forecast of 1985 rail ridership ($R_{INT,1985}$)--or productions by zone--is calculated as indicated in Equation 2, below. The bus (local or express) 1985 ridership-forecast equation differs only in the income elasticity term (-.25 instead of -.29).

$$R_{INT,1985} = \sum_i \left[\frac{P_{i,1985}}{P_{i,DY}} \left(\frac{FP_{1985}}{FP_{DY}}\right)^{.35} \left(\frac{I_{1985}}{I_{DY}}\right)^{-.29} \left(\frac{AO_i/POP_{i,1985}}{AO_i/POP_{i,DY}}\right)^{-.6} (R_{i,DY}) \right] \quad (2)$$

where:

$R_{INT,1985}$ = rail ridership in 1985 - intermediate forecast

$P_{i,1985}$ = total-trips production rate in zone "i" in 1985

$P_{i,DY}$ = total-trips production rate in zone "i" during year in which base data was collected

FP_{1985} = real gasoline price in Boston in 1985 (in 1967 dollars)

I_{1985} = Boston-SMSA per-capita income in 1985 (in 1967 dollars)

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[1] U. S. Bureau of the Census, Current Population Reports, Series P-25, No. 882, June 1980, and U. S. Bureau of the Census, Provisional Estimates of Social, Economic, and Housing Characteristics: States and Selected SMSA's, PHC-80-SI-1, 1982.

[2] John F. Kain, Gary R. Fauth, and Jeffrey Zax, Forecasting Auto Ownership and Mode Choice for U. S. Metropolitan Areas, U. S. Department of Transportation, Report No. DOT/RSPA/DPB-50/78-21, Volume 1, December 1978.

	Per-capita Income		Mean Gasoline Price per Gallon		Consumer Price Index (CPI)
	Absolute	Real*	Absolute	Real*	
1976	$ 6,300	$3,580	$ .60	$ .340	176.2
1978	7,350	3,720	.64	.323	197.8
1979	8,010	3,790	.99	.449	211.4
1982	10,300	3,790	1.25	.460	271.7
1985 (Projected)	-	3,790	-	.470	-

---

*Indicates absolute level multiplied by 100 and divided by the CPI to eliminate the effect of general inflation.

ESTIMATES OF BOSTON-SMSA PER-CAPITA
INCOME AND MEAN GASOLINE PRICE,
AND CONSUMER PRICE INDEX

Table
3-6

AO_i = automobiles registered in zone "i"

POP_i = population of zone "i"

$R_{i,DY}$ = transit-ridership production rate in zone "i" according to base survey

The sources of the population estimates and forecasts are those discussed in Section 3.1. Surveys of the distribution of 1976 commuter-rail, 1978 local-bus, and 1979 express-bus ridership, and counts of 1982 local-bus ridership are used in estimating historical ridership levels by zone, from which are derived the transit-ridership production rates.[1]

The estimated ridership from Equation 2 is allocated among attraction zones in a manner similar to that in which it is allocated among production zones. As indicated in Equation 3, the trips attracted to zone "j" are calculated according to changes in the total-trips attraction rates, gasoline price, and income. The total ridership estimated, following this procedure, is constrained to equal the total-ridership estimate derived from Equation 2.

$$R_{j,INT} = \left(\frac{A_{j,1985}}{A_{j,DY}}\right)\left(\frac{FP_{1985}}{FP_{DY}}\right)^{.35}\left(\frac{I_{1985}}{I_{DY}}\right)^{-.29} R_{j,DY} \left(\frac{R_{INT,1985}}{\sum_j R_{j,1985}}\right) \quad (3)$$

where:

$$R_{j,1985} = \left(\frac{A_{j,1985}}{A_{j,DY}}\right)\left(\frac{FP_{1985}}{FP_{DY}}\right)^{.35}\left(\frac{I_{1985}}{I_{DY}}\right)^{-.29} R_{j,DY}$$

$R_{j,1985}$ = transit trips attracted to zone "j" with projected 1985 socioeconomic characteristics and base-year level of service and fares

$A_{j,1985}$ = total-trips attraction rate in zone "j" in 1985

3.3 FORECASTING TRANSIT RIDERSHIP: THE LEVEL-OF-SERVICE AND FARE FACTORS

Intermediate ridersip estimates developed from Equations 2 and 3 must be modified to reflect the changes in cost of transit and level of service (such as fares, travel time, and access time) associated with the transit alternatives. The expected changes are in many cases substantial and would have a significant effect on ridership.

---

[1] Surveys taken as part of the Commuter Rail Improvement Program (November 1976), and Forest Hills-Needham Replacement Service Analysis (December 1979).

The arc elasticities to fare levels of rail and bus ridership, as indicated by analysis of empirical data, are about -.1 and -.4 respectively.[1] The elasticities to travel time of rail and bus ridership, as indicated by empirical observation, are about -.6[2] and -.4,[3] respectively. Models which simulate the effects of variations in access time suggest that rail and bus ridership are about 2.5-times as elastic to access time as to travel time,[4] indicating elasticities to access time of about -1.0, and -1.5, respectively.

Several other characteristics of transit service which are expected to change will also have some impact on ridership levels. For example, improvements in ride quality (resulting from newer rolling stock and refurbished tracks and rail beds) and greater reliability of service (i.e., more consistent on-time arrivals) are both expected to encourage more area residents to use the commuter rail service if it is reinstated. However, no means of quantifying the effects of changes in these characteristics upon ridership have been established. Therefore, such impacts cannot be incorporated into the analysis.

Taking the quantifiable fare and level-of-service factors into account, 1985 ridership forecasts for possible commuter rail service are calculated as indicated in Equation 4. Ridership forecasts are made for bus service in the same manner with the substitution of the appropriate elasticity terms (-.4 for -.1, -.4 for -.6, and -1.0 for -1.5).

$$R_{1985}=\sum_{b}(RAT_b^{-1.5}\sum_{d}\bigg[\bigg[\frac{F_{bd,1985}}{F_{bd,DY}}-1)(-.1))+1)\bigg[\bigg[\frac{T_{bd,1985}}{T_{bd,DY}}-1)(-.6))+1)R_{bd,INT}))$$

where:

R_{1985} = forecast of 1985 transit-service-alternative ridership

$F_{bd,1985}$ = fare to be charged (in 1982 dollars) for travel from station "b" to station "d" by this transit service in 1985

---

[1] Barton-Aschman Associates, Inc., Traveler Response to Transportation System Changes, prepared for Federal Highway Administration, July, 1981.

[2] T. J. Tardiff, J. L. Benhan, and S. Greene, Methods for Analyzing Fuel Supply Limitations on Passenger Travel, National Cooperative Highway Research Program, Report 229, December, 1980.

[3] Pucher and Rothenberg.

[4] Ibid., p.33.

$F_{bd,DY}$ = fare charged (in 1982 dollars) for travel from station "b" to station "d" by this transit service during year in which base data was collected

$T_{bd,1985}$ = time it takes to travel from station "b" to station "d" by this transit service in 1985

RAT_b = the ratio of average access time for riders boarding service at station "b" in 1985 to the average access time for riders boarding service at station "b" during the base data collection period

$R_{bd,INT}$ = ridership on service boarding at station "b" and disembarking at station "d" indicated by intermediate 1985 forecast

The travel times and fares used in producing the rail ridership forecasts are presented in Table 3-7. The 1976 fares and travel times are based on the 1976 Penn Central schedule for the Needham branch, while the times and fares for the 1985 alternative are as specified by C. E. Maguire.[1] It should be noted that the changes in fares do not take into account the charge in transit-pass policy, which now permits commuter rail riders to use their monthly passes as rapid-transit passes. While this policy in effect reduces the present cost of public transportation for pass holders and would thus attract more riders, the lack of information on rapid transit usage by commuter rail pass holders prevents the quantification of this effect on ridership.

The ridership under each alternative is distributed among attraction stations by assuming the ridership produced by each station remains distributed among the attraction stations in the same proportional manner.

The ridership estimates and forecasts are presented in summary form for each mode, by alternative, in Table 3-8, along with the associated peaking factors.[2] Express-bus and local-bus ridership are expected to fall slightly due to demographic changes, while commuter rail ridership is expected to increase somewhat due to service improvements. These results are discussed in greater detail in Chapter 4.0.

---

[1] It was assumed that the fare charged for travel between the four Needham stations and the stations in Roslindale and West Roxbury equals the fare charged for travel between Back Bay and South Station--$.80 in 1976 ($1.23 in 1982 dollars) and $1.25 in 1985 (in 1982 dollars).

[2] Ridership is defined as the sum of the number of riders on all trips on one day.

	TRAVEL TIME (MINUTES)						FARE (1982 $)	
	Destination Station							
	Back Bay			South Station				
Boarding Station	1976	Alt.A*	Alt.B*	1976	Alt.A*	Alt.B*	1976	Alt.A&B*
Needham Heights	37.7	33.5	31.7	42.4	36.9	35.0	$2.08	$1.75
Needham Center	34.7	30.4	28.5	39.4	33.7	31.9	2.01	1.75
Needham Junction	31.3	27.0	25.1	36.0	30.3	28.5	1.93	1.50
Bird's Hill	28.3	23.1	21.2	33.0	26.4	24.6	1.85	1.50
West Roxbury	22.7	17.0	15.1	27.4	20.3	18.5	1.47	1.25
Highland	20.5	14.6	12.7	25.2	17.9	16.1	1.47	1.25
Bellevue	17.5	12.1	-	22.2	15.5	-	1.31	1.25
Roslindale	14.3	9.1	9.1	19.0	12.4	12.4	1.31	1.25
Forest Hills	10.5	5.3	5.3	15.2	8.6	8.6	1.23	1.25

---

*Alternative A assumes service at all stations, while Alternative B assumes that Bellevue Station remains closed.

Table 3-7

TRAVEL TIMES AND FARES IN COMMUTER-RAIL RIDERSHIP FORECASTS

Peaking Factors[1]		1976	1978	1979	1982	Alt. A	Alt. B	Alt. C
.88	Commuter rail[2]	2,960	2,672	--	--	3,094	3,055	--
.86	Express Bus 310[3]	--	--	1,641	2,700	--	--	2,664
1.00	Express Bus 315[4]	--	--	--	300	--	--	295
--	Line-haul totals	2,960	2,672	NA	3,000	3,094	3,055	2,959
.55	Local buses[4]	--	34,450	--	26,600	26,074	26,103	26,251
--	TOTAL	NA	37,122	NA	29,600	29,168	29,158	29,210

---

[1] Portion of forecast 24-hour line volumes expected to use service during peak periods. Based on 1976 Commuter Rail Improvement Program, 1979 Replacement Service Analysis (Route 310), and 1982 peak-load counts (Route 315 and local bus routes).

[2] Historical ridership estimates from CTPS, CRIP Plan Refinement Study Final Report, January 1979.

[3] Historical ridership estimates from MBTA peak-load counts and CTPS, Evaluation of Needham Express Bus Service and Framingham Commuter Rail Service, June 1981.

[4] Historical ridership estimates from MBTA peak-load counts.

NA = Not Available.

Table
3-8

ESTIMATES AND FORECASTS OF DAILY RIDERSHIP
ON TRANSIT SERVICE IN THE STUDY AREA

4.0 RIDERSHIP FORECASTS FOR THE TRANSIT-SERVICE ALTERNATIVES

Using the demographic, ridership, and level-of-service data that have been presented and following the analysis methodology discussed in Chapter 3.0, 1985 ridership forecasts have been prepared for each of the three transit-service alternatives for the Forest Hills-Needham corridor. These three alternatives are: (A) commuter rail service from Needham through Roslindale and West Roxbury and local bus service in Roslindale and West Roxbury; (B) commuter rail and local bus service similar to Alternative A, but without service at the Bellevue commuter rail station; and (C) express bus service from Needham and Roslindale/West Roxbury, with local bus service in Roslindale and West Roxbury. Descriptions of these alternatives and the ridership forecasts are presented below. The forecasts of local bus ridership are addressed separately, in the concluding section of this chapter.

4.1 COMMUTER RAIL RIDERSHIP UNDER ALTERNATIVE A

Under Alternative A, commuter rail service would be reinstituted on the Needham branch. In addition, equipment and infrastructure improvements would make the service faster and more comfortable than the service provided along this corridor before its discontinuation in 1979. The average headway between trains would be 30 minutes during the morning and evening peak periods and 60 minutes during the midday, off-peak period. Peak-period trains would have five cars, off-peak-period trains three cars. The expected travel times and fares are presented in Table 3-7.

According to the survey taken as part of the Commuter Rail Improvement Program (CRIP), 1979 daily ridership on the Needham branch was about 2,974 and was distributed among production and attraction zones and production and attraction stations as indicated in Tables 4-1 and 4-2, respectively. The commuter-rail ridership changes expected as a result of demographic and gasoline-cost changes are forecast by production and attraction zone according to the methodology presented in Section 3.2. Assuming the distribution of boarding stations used by the residents of each zone indicated in CRIP (see Table 4-3), the distribution of ridership by production and attraction stations is estimated for the intermediate forecast and, following the methodology discussed in Section 3.3, for the final Alternative A forecast.

	1976*		1985 Alternative A		1985 Alternative B	
Zone	Prod.	Attract.	Prod.	Attract.	Prod.	Attract.
1	541	5	554	0	570	0
2	205	0	213	0	221	0
3	265	8	283	0	290	0
4	325	0	366	0	377	0
5	104	0	105	0	108	0
NEEDHAM TOTAL	1,440	13	1,521	0	1,566	0
6	120	0	134	0	135	0
7	143	18	137	18	127	19
8	122	0	118	0	123	0
9	159	0	166	0	170	0
10	5	0	5	0	5	0
11	0	0	0	0	0	0
12	55	0	53	0	53	0
13	140	0	133	0	114	0
14	221	0	228	0	149	0
15	0	0	0	0	0	0
16	5	0	6	0	6	0
17	5	0	6	0	6	0
18	0	0	0	0	0	0
24	3	0	3	0	3	0
25	192	0	206	0	212	0
26	52	0	58	0	60	0
27	0	0	0	0	0	0
28	60	5	66	0	65	0
29	39	0	40	0	40	0
MARKET-AREA TOTAL	2,761	36	2,880	18	2,834	19

---

*Source: CTPS, Commuter Rail Improvement Program Plan Refinement Study, Final Data Files, 1976

DISTRIBUTION OF DAILY COMMUTER RAIL
RIDERSHIP BY PRODUCTION AND ATTRACTION
ZONES (1976 AND 1985)

Table
4-1
(p.1)

	1976*		1985 Alternative A		1985 Alternative B	
Zone	Prod.	Attract.	Prod.	Attract.	Prod.	Attract.
30	16	26	15	22	15	22
31	0	0	0	0	0	0
32	8	0	8	0	9	0
33	0	63	0	67	0	70
34	0	29	0	31	0	30
35	0	39	0	47	0	41
36	0	267	0	284	0	286
37	0	345	0	304	0	304
38	0	118	0	130	0	127
39	0	1,448	0	1,563	0	1,542
40	0	227	0	281	0	271
41	0	31	0	43	0	44
42	0	16	0	16	0	16
43	0	206	0	209	0	203
44	0	21	0	19	0	19
45	0	0	0	0	0	0
46	0	16	0	20	0	20
Other	189	37	191	42	197	41
STUDY-AREA TOTAL	2,974	2,974	3,094	3,094	3,055	3,055

---

*Source: CTPS, Commuter Rail Improvement Program Plan Refinement Study, Final Data Files, 1976

DISTRIBUTION OF DAILY COMMUTER RAIL
RIDERSHIP, BY PRODUCTION AND ATTRACTION
ZONES (1976 AND 1985)

Table
4-1
(p.2)

Station	1976*		1985 Alternative A		1985 Alternative B	
	Prod.	Attract.	Prod.	Attract.	Prod.	Attract.
Needham Heights	199	0	206	0	211	0
Needham Center	271	0	309	0	317	0
Needham Junction	735	0	868	0	892	0
Bird's Hill	616	0	617	0	637	0
West Roxbury	318	40	268	38	278	38
Highland	259	10	270	10	325**	10
Bellevue	213	0	211	0	0	0
Roslindale	363	4	345	4	395***	4
Forest Hills	0	4	0	4	0	4
Back Bay	0	912	0	927	0	905
South Station	0	2,003	0	2,111	0	2,094
TOTAL	2,974	2,974	3,094	3,094	3,055	3,055

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*Source: CTPS, Commuter Rail Improvement Program Plan Refinement Study, Final Data Files, 1976

**This total includes 44 riders who would have otherwise boarded at Bellevue Station.

***This total includes 50 riders who would have otherwise boarded at Bellevue Station.

DISTRIBUTION OF DAILY COMMUTER RAIL RIDERSHIP
BY PRODUCTION AND ATTRACTION STATIONS (1976 AND 1985)

Table
4-2

Zone of Residence	Boarding Station NH	NC	NJ	BH	WR	H	B	R
1	0	7.8%	3.4%	87.3%	0	0	1.5%	0
2	37.7%	18.2%	7.8%	36.4%	0	0	0	0
3	1.0%	5.9%	93.1%	0	0	0	0	0
4	9.7%	55.6%	33.1%	1.6%	0	0	0	0
5	80.0%	2.5%	15.0%	2.5%	0	0	0	0
6	0	0	0	0	70.2%	23.4%	6.4%	0
7	0	0	0	0	25.0%	55.4%	19.6%	0
8	0	0	0	0	14.6%	85.4%	0	0
9	0	0	0	0	53.3%	25.0%	5.0%	16.7%
10	0	0	0	0	0	0	0	100.0%
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	100.0%
13	0	0	0	0	0	0	27.8%	72.2%
14	0	0	0	0	0	0	53.7%	46.3%
15	0	0	0	0	0	0	0	0
16	0	0	0	0	100.0%	0	0	0
17	0	0	100.0%	0	0	0	0	0
18	0	0	0	0	0	0	0	0
24	0	100.0%	0	0	0	0	0	0
25	0	2.7%	97.3%	0	0	0	0	0
26	0	0	100.0%	0	0	0	0	0
27	0	0	0	0	0	0	0	0
28	0	0	0	38.1%	28.6%	9.5%	0	23.8%
29	0	0	53.3%	46.7%	0	0	0	0
30	0	0	0	0	0	0	0	100.0%
31	0	0	0	0	0	0	0	0
32	0	0	0	0	0	66.7%	0	33.3%
Other	2.8%	0	80.2%	0	4.2%	2.8%	0	9.9%
TOTAL	6.7%	9.1%	24.7%	20.7%	10.7%	8.7%	7.2%	12.2%

Source: Commuter Rail Improvement Program Survey, 1976.

DISTRIBUTION OF COMMUTER RAIL PASSENGERS BY
BOARDING STATION AND RESIDENCE (1976)

Table
4-3

The results indicate that daily ridership on the Needham branch would increase to about 3,094 in 1985 under Alternative A, with productions increasing the most between 1976 and 1985 at the Needham Center and Needham Junction stations, and suffering the greatest drops over that period at the West Roxbury and Roslindale stations. The results are presented in Table 4-2.

Weighting the changes in travel times and fares according to the distribution of zonal resident riders by production and attraction stations, zonal productions and attractions of 1985 Alternative A ridership are estimated using the same methodology. As indicated in Table 4-1, the number of trips by Needham and market area residents are forecast to increase from 1,440 to 1,521 and from 2,761 to 2,880, respectively, between 1976 and 1985.

4.2 COMMUTER RAIL RIDERSHIP UNDER ALTERNATIVE B

The commuter rail service provided under this alternative is identical to the service which would be offered under Alternative A, except that the Bellevue commuter rail station would be closed. The estimated fare levels and travel times are presented in Table 3-7. Travel-time reductions for riders boarding at stations outbound from Bellevue would lead to some ridership increases, while the additiional time required to access service by those riders who would prefer to use Bellevue Station would lead to some ridership reductions. Study of a map of the area around Bellevue Station indicates that the average access time for those switching from that station to either Highland or Roslindale would increase by about 75 percent.

Following the same forecasting procedure as was used for the Alternative A estimate, and assuming that those otherwise using Bellevue Station would switch to either the Highland or Roslindale Station (whichever is closer), the results obtained (summarized in Tables 4-1 and 4-2) indicate that daily commuter rail ridership under Alternative B would be about 3,055 in 1985. While this is about 2.7-percent higher than the 1976 ridership level, it is also 1.3-percent below the commuter-rail ridership forecast under Alternative A.

Relative to Alternative A, ridership at the stations other than Bellevue increases by about 2.7 percent, but less than 45 percent of the riders who would otherwise board the train at Bellevue switch to other stations. Furthermore, following expectations, the number of Needham and market-area residents using commuter rail is nearly 3.0-percent greater and about 1.6-percent smaller, respectively, under Alternative B than under Alternative A (see Table 4-1).

4.3 EXPRESS BUS RIDERSHIP UNDER ALTERNATIVE C

Under this alternative, the present express-bus service (Routes 310 and 315) would remain and commuter rail service would not be provided. The features of this express bus service are summarized in Table 4-4. Estimates of off-peak ridership, a 1979 CTPS on-board peak-period survey, and the 1982 MBTA peak-load counts were used to make daily ridership estimates.

As indicated in Table 4-5, the daily ridership on express-bus Route 310 was about 1,641 and 2,700 in 1979 and 1982, respectively. Also shown in this table is the distribution of 1979 ridership among bus stops. It should be noted that over 26 percent of these riders apparently have better access to the bus than to the commuter rail service, as they board the bus at stops located away from the rail stations.

It is assumed that the riders boarding at each of the bus stops are distributed among the residence zones within each town in the same proportional manner as were the commuter rail users who boarded at the rail station which the express-bus Route 310 riders using that stop indicated they had previously used. The resultant distribution of ridership on Route 310 among production and attraction zones is projected to 1982 and 1985 following the same procedures as used for the commuter rail forecasts. Since ridership on Route 310 has grown dramatically since the survey of riders' residences, and ridership increases would most likely be concentrated outside of Needham, this distribution most likely overestimates the number of Needham residents and underestimates the number of non-Needham residents riding Route 310.

These estimates are added to the corresponding figures for Route 315, which are arrived at by assuming that: (1) all Route 315 riders are Roslindale and West Roxbury residents and (2) the residence and work zones of all Roslindale and West Roxbury express-bus users (310 and 315) are distributed in the same proportions as are the Roslindale and West Roxbury residents using the Needham commuter-rail branch. The resultant estimates and forecasts are presented in Table 4-6. Assuming in the same manner that the residents of each zone remain distributed among bus stops in a constant proportion, that distribution changes over time as indicated in Table 4-5. Total ridership on Route 315 falls from 300 in 1982 to 295 in 1985.

4.4 LOCAL BUS RIDERSHIP UNDER THE THREE ALTERNATIVES

In addition to commuter rail or express bus service, the transit alternatives also include twelve local bus routes. Under all three alternatives, service along these routes would continue at the present levels, as summarized in Table 4-7. MBTA bus-ridership counts indicate that in 1978 and 1982 about 34,450 and 26,600 persons, respectively, rode these local buses daily. As indicated in Table 4-8, the Route 32 bus carried the most passengers on the average day.

The distribution of the boardings and alightments along these routes was indicated by a 1978 MBTA survey. These trips were

Route Number	Route	Headway (Minutes)			Trip Time (min.)	Fares (in 1982 Dollars)
		AM Peak	Mid-Day	Evening		
310	Needham Jct.-Downtown Boston (via Great Plain Ave.)	5-10	60	--	42	$1.50
310	Needham Jct.-Copley Square (via Great Plain Ave.)	5-10	60	--	38	1.50
310	Needham Jct.-Downtown Boston (via Highland Ave.)	5-10	--	--	36	1.50
310	Needham Jct.-Copley Square (via Highland Ave.)	5-10	--	--	32	1.50
315	Roslindale Square-Copley Square	30	--	--	48	1.25

ALTERNATIVE C (1985):
EXPRESS-BUS TRAVEL TIMES AND FARES

Table
4-4

Production Stop	1979	1982	1985 Alternative C
Needham Junction	445	709	703
Chestnut	42	71	70
Needham Center	173	276	273
Gt. Plain-Bradford	77	126	124
Gt. Plain-Wilshire	115	191	187
Bird's Hill	438	765	750
Gt. Plain-South	61	98	96
Highland-May	23	32	32
Highland-Oakland	0	0	0
Highland-Rosemary	40	66	65
Highland-Dana	12	16	16
Needham Heights	150	249	248
Highland-Webster	63	101	100
TOTAL-Route 310	1,641	2,700	2,664
TOTAL-Route 315	-	300	295

EXPRESS BUS DAILY RIDERSHIP: DISTRIBUTION BY STOP (1979, 1982, 1985)

Table 4-5

Zone	1982		1985 Alternative C	
	Productions	Attractions	Productions	Attractions
1	949	0	928	0
2	304	0	300	0
3	457	0	452	0
4	445	0	442	0
5	140	0	142	0
Needham Residents	2,295	0	2,264	0
6	45	0	45	0
7	48	0	47	0
8	41	0	40	0
9	57	0	56	0
10	2	0	2	0
11	0	0	0	0
12	18	0	18	0
13	47	0	46	0
14	77	0	76	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	4	0	4	0
24	0	0	0	0
25	179	0	178	0

EXPRESS BUS DAILY RIDERSHIP:
DISTRIBUTION BY PRODUCTION AND
ATTRACTION ZONES (1982 AND 1985)

Table
4-6
(p.1)

	1982		1985 Alternative C	
Zone	Productions	Attractions	Productions	Attractions
26	39	0	39	0
27	0	0	0	0
28	43	0	43	0
29	35	0	31	0
MARKET-AREA TOTAL	2,930	0	2,889	0
30	0	41	0	41
31	0	0	0	0
32	0	0	0	0
33	0	108	0	107
34	0	19	0	19
35	0	41	0	41
36	0	250	0	248
37	0	311	0	308
38	0	140	0	139
39	0	1,446	0	1,419
40	0	315	0	310
41	0	77	0	76
42	0	24	0	24
43	0	165	0	164
44	0	28	0	28
45	0	0	0	0
46	0	12	0	12
Other	70	23	70	23
STUDY-AREA TOTAL	3,000	3,000	2,959	2,959

EXPRESS BUS DAILY RIDERSHIP:
DISTRIBUTION BY PRODUCTION AND
ATTRACTION ZONES (1982 AND 1985)

Table
4-6
(p.2)

Route Number	Corridor of Service	Headways (min.)			One-Way Trip Times (min.)
		AM Peak	Mid-Day	Evening	
30	Mattapan-Roslindale Square	20	30	60	12
32	Walcott Square Arborway	20	20	60	19
34	Dedham Line-Arborway	7	30	60	15
34E	East Walpole-Arborway	15	30	60	42
35	Dedham Mall-Arborway	12	30	60	28
36	Charles River-Arborway	10	30	60	20
37	Vermont Street-Arborway	20	30	--	15
38	Wren Street-Forest Hills	22	40	--	17
40	Georgetown-Arborway	35	30	--	16
50	Cleary Square-Arborway	20	60	--	20
51	Cleveland Circle-Arborway	20	60	120	30
52	Dedham Mall-Watertown Square	37	45	--	37

SUMMARY OF LOCAL BUS SERVICE
(1982 AND 1985)

Table
4-7

Route Number	1978	1982	1985 Alternative C	Peaking Factor*
30	1,550	900	890	.66
32	6,100	5,200	5,140	.46
34	5,650	3,600	3,552	.45
34E	3,450	3,400	3,349	.73
35	2,700	2,200	2,143	.57
36	4,350	3,300	3,249	.50
37	2,300	2,000	1,973	.52
38	1,700	1,000	987	.59
40	1,200	1,200	1,191	.67
50	1,750	400	394	.55
51	2,850	1,800	1,788	.59
52	850	1,600	1,595	.53
TOTAL	34,450	26,600	26,251	.55

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*Portion of forecast 24-hour line volumes expected to use peak-period service

DISTRIBUTION OF DAILY LOCAL BUS RIDERSHIP
BY ROUTE (1978, 1982, 1985)

Table
4-8

assigned to production and attraction zones, according to a comparison of the routes and the zonal structure. The results are presented in Table 4-9. Assuming that the zonal distribution of riders along each route remained the same in 1982, estimates indicate that about 57 percent of the 1982 local bus riders came from outside the market area, with more riders boarding in Zone 32 than any other zone; more riders board in Zone 13 than any other market-area zone.

Forecasts made according to the method presented above to forecast Alternative A ridership indicate that about 26,250 persons will ride local buses daily in 1985 if transit service within the area remains the same as in 1982 (Alternative C). This ridership would be distributed by production and attraction zone as indicated in Table 4-9, with ridership on each of the routes at the levels presented in Table 4-8. Local bus forecasts for Alternatives A and B were not made at the station or zonal level for the reason explained below.

Forecasting local bus ridership under Alternatives A and B cannot be accomplished with the method used for forecasting the commuter rail ridership under those alternatives, because the local-bus routes are not the same as when commuter rail was formerly in service. For the same reason, these local bus forecasts were not made at the route and zonal levels. Total forecasts for Alternatives A and B were made by manipulating the local-bus forecast for Alternative C. This procedure involves the following assumptions: (1) 25 percent of those travelers who would board commuter rail at stations in West Roxbury and Roslindale under Alternatives A and B would take local buses to Forest Hills to access rapid transit under Alternative C; (2) the portion of commuter rail riders accessing each station by local bus remains the same under Alternatives A and B as in 1976; (3) the portion of commuter rail riders accessing stations in West Roxbury and Roslindale by local bus under Alternative A is the same as the portion of express bus riders accessing Route 315 by local bus under Alternative C.

Under the above assumptions, daily local-bus ridership under Alternatives A and B in 1985 could be expected to be 26,074 and 26,103, respectively. The number of travelers accessing commuter rail service by local bus under these alternatives is greater than the number accessing express bus service by local bus under Alternative C. However, this difference is outweighed by the larger number of riders under Alternative C who take local bus to Forest Hills.

The transit services provided under Alternative C would thus together carry about 29,210 riders on an average day in 1985. Of these riders, about 8 percent and 48 percent would be Needham and market-area residents, respectively.

	1978		1982		1985 Alternative C	
Zone	Origin	Dest.	Origin	Dest.	Origin	Dest.
6	928	876	877	874	861	855
7	809	1,242	626	983	607	961
8	1,225	1,673	955	1,287	928	1,264
9	785	1,005	619	832	602	817
10	368	587	302	434	291	431
11	305	307	258	265	254	263
12	865	833	610	616	599	605
13	4,505	5,110	2,956	3,475	2,901	3,405
14	3,295	3,338	2,271	2,397	2,232	2,344
15	143	57	99	39	98	40
16	119	68	223	131	219	133
28	1,185	1,236	1,187	1,273	1,187	1,272
29	444	274	422	263	374	260
MARKET-AREA TOTAL	14,976	16,606	11,402	12,867	11,153	12,657
30	4,376	3,661	3,109	2,532	3,080	2,509
32	12,287	11,243	9,070	8,271	8,997	8,177
Other	2,811	2,940	3,019	2,930	3,021	2,908
STUDY-AREA TOTAL	34,450	34,450	26,600	26,600	26,251	26,251

DISTRIBUTION OF DAILY LOCAL BUS RIDERSHIP
BY ORIGIN AND DESTINATION ZONES (1978, 1982, 1985)

Table
4-9

5.0 SUMMARY

Analysis of the three transit-service alternatives for the Forest Hills-Needham corridor being considered in this report, indicates only a slight variation in ridersip among them. As indicated in Table 5-1, ridership on the line-haul modes (commuter rail and express bus) would be greatest under Alternative A and smallest under Alternative C, but the differences are relatively small compared to the possible range of error of the pivot-point analysis used in this study. The Bellevue commuter rail station being closed under Alternative B appears to result in that alternative's commuter rail ridership being a little more than one percent lower than Alternative A's; most of those travelers who would board at Bellevue under Alternative A would also use commuter rail under Alternative B, boarding at other stations.

Commuter rail service could be expected to attract more riders from outside the communities with rail stations than express bus service. Express buses would be used more extensively than commuter rail by Needham residents, while the reverse would be true of West Roxbury and Roslindale residents.

Over 93 percent of the commuter rail riders under Alternative A would be market-area residents, as would nearly 93 percent of Alternative B commuter rail riders. Nearly 98 percent of the express bus riders (Alternative C) would be market-area residents. Since the overall number of express bus riders is similar to that of commuter rail riders, this indicates that fewer non-market-area residents are using the market area's line-haul transit under Alternative C; it should be noted that some of these travelers who would choose not to use the express bus service would not travel by auto instead, but would use other commuter rail lines (mainly the Framingham line).

Needham residents are forecast to make over 1,520 commuter rail trips daily under Alternative A (a few of these riders boarding outside of Needham), and about 1,566 under Alternative B. They are forecast to make about 2,264 express bus trips daily under Alternative C. While this includes a probable overestimate of the portion of Route 310 riders residing in Needham (brought about by the limited data available), a significant number of Needham residents would use the express bus service but not the commuter rail service provided under the other alternatives.

Although local bus ridersihp would be expected to decline slightly if commuter rail service were reinstituted, it does not vary significantly among the alternatives. Total transit ridership in the corridor would be largest with the continuation of present express bus and local bus services (Alternative C), as indicated in Table 5-1. It would be 0.15 percent lower under Alternative A, 0.2 percent lower under Alternative B.

	Base Case[1]				1985 Alternative A			
	Group 1[2]	Group 2[3]	Group 3[4]	Total	Group 1	Group 2	Group 3	Total
Commuter Rail	1,153	389	1,432	2,974	1,094	487	1,513	3,094
Express Bus 310	0	405	2,295	2,700	-	-	-	-
Express Bus 315	300	0	0	300	-	-	-	-
Total Line-haul	NA	NA	NA	NA	1,094	487	1,513	3,094
Local Buses	26,600	0	0	26,600	26,074	0	0	26,074
TOTAL	NA	NA	NA	NA	27,168	487	1,513	29,168

	1985 Alternative B				1985 Alternative C			
	Group 1	Group 2	Group 3	Total	Group 1	Group 2	Group 3	Total
Commuter Rail	998	500	1,557	3,055	-	-	-	-
Express Bus 310	-	-	-	-	0	400	2,264	2,664
Express Bus 315	-	-	-	-	295	0	0	295
Total Line-haul	998	500	1,557	3,055	295	400	2,264	2,959
Local Buses	26,103	0	0	26,103	26,251	0	0	26,251
TOTAL	27,101	500	1,557	29,158	26,546	400	2,264	29,210

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[1] Base-case ridership for commuter rail service is at 1976 levels, while base-case ridership for express and local buses is at 1982 levels.

[2] Includes only those transit riders boarding at stations or stops located outside of Needham.

[3] Includes only those transit riders boarding at stations or stops located in Needham who do not reside in Needham.

[4] Includes only those transit riders who are Needham residents and board at stations or stops in Needham.

Table 5-1

SUMMARY OF RIDERSHIP FORECASTS FOR
TRANSIT-SERVICE ALTERNATIVES